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Enhancing and Promoting Phosphorus Availability in two Summer Forage Legumes

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ABSTRACT

Experiments were designed and implemented to evaluate fresh and dry forage yield, vegetative growth behaviour, and quality determinations of two indigenous-native legumes (Bonavista bean and Fodder cowpea) under six sources of promoting phosphorus treatments: Control**,** sulpher as a content, soil application of calcium super phosphate**,** sulpher+ calcium super phosphate**,** soil phosphoric acid**,** foliar phosphoric acid and phosphoric acid as soil+foliar application. Two field experiments were carried out at the Experimental Research station, Faculty of Agriculture, Moshtohor, Benha University, Qalyubia Governorate during two summer growing seasons (2011 and 2012). Results could be concluded as follows:

Data clarified significant differences in total fresh and dry forage yield for each of Bonavista bean and Fodder cowpea types. Highest production of fresh and dry forage yield; Leaf: Stem ratio; plant height; CF% and P% contents were obtained for Whit B. bean. Whereas, the highest values of number of shoots/m^2 and CP% were recorded for Creamy Fodder cowpea type with significant differences of variable magnitudes.

Concerning promoting phosphorus source treatments: the highest values of the studied parameters were obtained for fresh forage yield from using Sulpher; dry yield, number of shoots/$m^2$and CP% from using Sulpher+ Calcium super phosphate (1:1); CF% and P% from Calcium super phosphate; Leaf: Stem ratio from using Phosphoric acid as soil application and the tallest Plants from the control treatment, respectively with significant differences of various magnitudes.

Key words: Bonavista bean, Fodder cowpea, Phosphorus availability and its promoters.

Introduction

In Egypt, among the main target of the national plans for increasing food and feed productivities are enhancing the agricultural production and quality at reasonable alternative sustainable agronomic practices. In this respect, the severe lack of production of forage leguminous crops all year round and especially during summer seasons where there is severe shortage of crude protein sources to satisfy the requirements of ruminant animal feeding.

The concentration of available soil Pi seldom exceeds 10 µM (Bieleski, 1973), which is much lower than that in plant tissues where the concentration is approximately 5 to 20 µM Pi (Raghothama, 1999).

With increasing demand of agricultural production and as the peak in global production will occur in the next decades, phosphorus (P) is receiving more attention as a nonrenewable resource (Cordell *et al.,* 2009; Gilbert, 2009).

As it is well known that phosphorus is an essential important mineral fertilizer for the grown forage crops especially legumes. Two selected leguminous forage crops of bonavista bean and cowpea (Saad, *et al.,* 2010) were under investigation. Therefore, the effect of P application on yield and quality of cowpea and bonavista bean and their P uptake were investigated.

Cowpea (*Vigna sinensis,* L.) is a forage legume belonging to leguminoseae family. Its value lies in its high crude protein content and its ability for drought tolerant and high palatability for ruminant animals as well. Also, a leguminous forage crop possesses the ability symbiotic nitrogen fixation through soil–rhizobia bacteria from the atmospheric nitrogen through its nodules and thereby grows well in desert and marginal soils. Moreover, its contribution to soil fertility improvement and its benefit as an acceptable food and fodder crops (Singh, 1999). The acute deficiency of phosphorus (as an energy promoter) can be so in some soils due to its accumulation in plant seed after cession of the vegetative growth where plant growth ceases as soon as the P stored in the seed is exhausted (Mokwunye *et al*., 1986).

Soil P deficiencies primarily results from either inherent low levels of soils P or depletion of the P through heavy consecutive crop plantations. For sustainable food production to meet the vast increase in populations especially in developing countries, the real need and shortage of P fertilizer application requirement is expected to increase (Brynes and Bumb, 1998). Morever, even when P fertilizers are applied to replenish soil fertility, about seventy to ninety percent of the P fertilizers are in their unavailable form due to the relatively high pH of the soil, P fertilizer as phosphorus phosphate with its various P_2O_5 levels (powder or granulated) are

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of low availibity without giving any immediate consideration to crop production (Holford, 1997). So, acquisition of P fertilizer by crops depends on soil and plant properties.

Plants have evolved properties contributing to a more efficient use of available soil P and to mobilize P from less available soil P fractions.

Genotypic differences in the effects of P on nodulation (Ankomah *et al*., 1995) and yield (Jain *et al*., 1986; Tenebe *et al*., 1995; Sanginga *et al*., 2000) of cowpea have been reported previously. However, mechanisms by which these cowpea varieties induced exhibit differential abilities to grow when various phosphorus fertilization sources or application methods are not completely understood.

In this respect, Mokoboki *et al.* (2000) noticed significant varietal effect of cowpeas on its chemical composition. Crude protein content is an important factor of such forage quality. Also, Jilani *et al.* (2001) reported similar investigations four legume species included lablab. and, Odunsi. (2003) studied the performance of nutrient digestibility of lablab (*Lablab purpureus*). He indicated from his constituent analysis that lablab contain 234.0 crude protein, 19.0 ether extract, 83.4 crude fiber, 116.0 ash and 467.0 g kg^{-1} nitrogen free extracts.

Moreover, Foster *et al.* (2009) evaluated 3 forage legumes (soybean, cowpea and pigeonpea) for their Leaf / stem ratio which decreased with maturity and was greater for cowpea than the other tested legumes.

The main target of this investigation was to evaluate the specific properties of growth behavior, forage yield and quality of the proposed indigenous-native herbaceous fodder cowpeas and Bonavista bean grown under various phosphorus sources and applications (as soil, foliar or both).

Materials and Methods

Two field experiments were carried out at the Experimental Research Station, Faculty of Agriculture, Moshtohor, Benha University, Qalyubia Governorate during two successive summer growing seasons (2011 and 2012) to evaluate the specific properties of growth behavior, yield and quality of the two indigenous native herbaceous legumes (Bonavista bean and Fodder cowpea) under the applied various phosphorus or phosphorus promoting treatments.

Experiments were layed out and statistically analyzed as split plot design which were each of the herbaceous legumes were randomly distributed in the main plots and phosphorus treatments in the split plots. Each experimental unit was 10.5 m^2 (3 x 3.5 m) of about 1/400 feddan area. Two individual cuts were obtained during each of the two summer growing seasons. Combined analysis of the two season was done after insuring the validity of partlet test (Steel and Torrie ,1981).The applied treatments were:

***I-Forage legumes types**:*

1-Bonavista bean (*Dolichos lablab,* L.) of White seed-coat.

2- Fodder cowpea (*Vigna sinensis,* L.) of Creamy seed-coat.

II-Enhancing and promoting phosphorus availability treatments:

The applied phosphorus fertilization and P promoting treatments are presented as follows:

Sulpher treatments	**Phosphoric acid treatments**
1-Sulpher (98%S) (Soil)	4-Phosphoric acid (85%) (soil)
2-Calcium super phosphate (15.5%P_2O_5) (Soil)	5-Phosphoric acid (85%) (foliar)
3-Sulpher+ Calcium super phosphate(1:1) (Soil)	6-Phosphoric acid (85%) (1/2 Soil +1/2 Foliar)
	7-Without (Control)

These treatments were selected and implemented considering Calcium super phosphate (15.5% P_2O_5) at a rate of 200 kg/fed is the standard recommended rate. Meanwhile, the application of sulpher and/or Phosphoric acid rates were calculated according to FAO (1975) and implemented according to the equivalent standard rate of Calcium super phosphate which were (13.4 kg as phosphorus) Phosphoric acid 50 liter of Orthophosphoric acid.

This is addition for Sulpher which was applied at a rate of 200 kg/fed. Also, it should be noted that sulpher and phosphoric acid are considered as promoters for phosphorus availability of the alkaline soils.

Moreover, the applied procedures as soil, foliar or both ways of the applied treatments were conducted for the selected in the applied treatments were introduced to find out the functional way for releasing the unavailability of phosphorus element due to the high PH of the soils.

Seeds of each of the two summer forage legumes (Bonavista bean and fodder cowpea) were brought from original indigenous-native regions of Upper Egypt (Aswan), where seeds were originated and proved to be the best out of the tested collections in yield and quality(Saad, *et al*., 2010) . The recommended generated seeding rates of each of the above forage crops were used (20 kg/fed for Bonavista bean and 30 kg/fed for Fodder cowpea). Sowing dates were on May, 19^{th} in each of the two successive seasons.

Two subsequent cuts were taken for each of the two growing seasons (2011&2012). The first cuts were obtained at 60 days from sowing and the second one was at 40 days later. The prevailing Agrometrological factors during each of the two growing seasons are recorded in Table (1).

Table 1: The prevailing climatic factors at Qalyubia Governorate during each of the two growing seasons.

Season	First season (2011)					Second season (2012)				
Climatic factors / Month	Soil Temp. (˚C)	Solar radiation (w/m²)	Wind speed (m/sec)	Air Temp. (˚C)	Dew Point (˚C)	Soil Temp. (˚C)	Solar radiation (w/m²)	Wind speed (m/sec)	Air Temp. (˚C)	Dew Point (˚C)
1-15 June	27.1	252.7	1.42	24.9	16.1	29.9	255.3	1.60	25.5	16.7
16-30 June	28.0	245.1	1.51	24.9	16.8	30.2	241.6	1.00	27.5	20.3
1-15 July	32.56	243.9	1.26	26.4	19.1	30.6	238.8	1.00	27.9	20.8
16-31 July	31.8	245.7	1.12	27.4	21.2	30.3	228.2	0.75	27.7	22.9
1-15 August	30.1	229.4	1.00	26.6	20.7	27.7	207.0	0.60	28.8	22.7
16-31August	28.8	181.3	0.63	25.3	20.3	28.6	193.8	0.50	28.5	19.3
1-15 September	27.1	132.8	0.89	23.8	18.8	28.7	164.6	0.80	23.9	20.1
16-30September	26.7	196.6	0.84	24.1	18.2	28.2	154.4	0.60	24.6	17.9
Average	29.02	215.94	1.08	25.42	18.9	29.27	210.5	0.86	26.8	20.08

Agrometrological stating of the Faculty of Agriculture, Moshtohor, Benha Univ., Kalubia Governorate.

Studied parameters:

A-Vegetative growth behaviour:

Ten plants were randomly selected from the inter center of each experimental plots and during each of the two growing seasons right before mowing for studying the following traits: Plant height (cm); Leaf / stem ratio (which estimated on fresh weight basis) and Number of shoots/m².

B-Fresh and dry forage yield:

The whole fresh forage yield of each experimental unit for the grown forage yield under study was determined for each of the subsequent cuts and for each of the two studied seasons, then weighted using field scale of 0.5 kg sensitivity and forage yield was estimated and recorded in ton / fed., accordingly.

C-Determination dry matter content and estimated the total dry yield:

Samples of about 200 gm of fresh forage were selected randomly from each experimental unit just before mowing the whole experimental plot, accurately weighted using an electric balance of 0.01 gm sensitivity. Such obtained fresh samples were dried in an air forced drying oven at 105°C for 3 hours till constant weight to determine the dry matter content. Then, dry yield per feddan was estimated, accordingly.

Chemical analysis:

Chemical analysis was conducted and presented on dry matter basis (for each season). Fresh forage samples were randomly taken (through quadrate of ¼ sq meters) from each experimental unit. Samples of the proposed treatments were properly prepared. Accurately weighed samples of the fresh forage of about 200 gm were dried using an air forced drying oven at 75°C till constant weight.

Samples were dried in a labeled Kraft paper bags which were laid in an air forced drying oven all over the drying period till constant weight. Dried samples were then cooled at room temperature, ground finely and screened using hummer mill of 40 michs. Prepared samples were kept in sealed labeled plastic bags and stored in the refrigerator at 5°C till needed for the chemical analysis.

The chemical analysis of forage quality components (on dry matter basis) included the following:

1-Crude protein (CP) content:

Total nitrogen percentage was determined according to the modified micro kjeldahl method. Crude protein content was estimated by multiplying nitrogen percentage by 6.25 (A.O.A.C., 1995).

2-Crude fiber (CF) content:

Crude fiber percentage was determined according to the A.O.A.C. (1995).

3- Phosphorus (P) content:

Phosphorus percentage was determined according to the A.O.A.C. (1995).

Statistical analysis:

The analysis of variance for each of the two growing seasons and their combined analysis was conducted after insuring the validity of partlet test according to the procedure described by Steel and Torrie (1981). The L.S.D. test at 5% level was used for means comparison.

Results and Discussion

Fresh forage yield:

Data in Table (2) represent fresh forage yield for each of the grown studied forage legumes as affected by various phosphorus and its promoting treatments for each of the obtained cuts of two growing seasons and their combined analysis as well.

Over the applied phosphorus and its promoting treatments, results of the combined analysis indicated appreciable significant differences in total fresh forage yield between the two studied forage legumes. The white Bonavista bean was higher in total fresh forage yield (22.13) than creamy Fodder cow pea (15.70 ton/fed). So, the white B.bean was of about 41% higher in fresh forage yield as compared with F.cowpea. Similar comparative studies were conducted by Jain *et al*. (1986), Tenebe *et al*. (1995) and Sanginga *et al*. (2000) in Fodder cowpea and Saad *et al.,* (2010) in Fodder cowpea and lablab.

Over the grown forage legumes, combined analysis clarified significant differences among the availability of the applied soil phosphorus and its promoting treatments as compared with the control $_{(18.64\ ton/fed)}$. Total fresh forage yield productivity could be ranked in the following descending order: sulpher $_{(19.87)}$, sulpher + calcium super phosphate $_{(19.86)}$ and calcium super phosphate $_{(18.86\ ton/fed)}$ for soil application.

Regarding the effect of phosphoric acid application, total fresh forage yield productivity could be ranked in the following descending order: soil phosphoric acid $_{(19.80)}$, foliar phosphoric acid $_{(17.77)}$ and phosphoric acid in soil +foliar application $_{(17.60\ ton/fed)}$for phosphoric acid application as compared to the control $_{(18.64\ ton/fed)}$ (Table 2).

In this respect, B. bean produced the highest fresh forage yield (23.47 ton/fed), decreased when applied as foliar application (21.40) and slight extra decrease when applied in two halfs ($^1/_2$ soil + $^1/_2$ foliar). Differences were significant in the combined analysis of the two seasons. Whereas, F.cowpea produced the highest fresh forage yield (16.13 ton/fed) when phosphoric acid applied to the soil similar to B.bean with lower magnitudes (16.13ton/fed). Moreover, foliar phosphoric acid and in two halfs ($^1/_2$ soil + $^1/_2$ foliar) did not exert appreciable differences which were 14.13 and 14.67 ton/fed respectively, with no significant differences than their control (16.13 ton/fed).

In conclusion, soil phosphoric acid application produced the highest fresh forage yield for B.bean and F. cowpea (compared to their control). Its soil application is more effective than foliar or $^1/_2$ foliar +$^1/_2$ soil application.

The superiority of phosphoric acid as soil application is very well accepted, since phosphoric acid has phosphorus in its constituents in addition to its effect in reducing the soil PH (decreasing its alkalinity).These two mechanisms enhances the availability of phosphorus in the alkaline soils for the sake of P availability for plants in respect of their proper absorption and functions in generating the required energy for plant growth and development.

In this respect, Shen *et al. (*2011) reported that maintaining a proper P-supplying level at the root zone can maximize the efficiency of plant roots to mobilize and acquire P from the rhizosphere by an integration of root morphological and physiological adaptive strategies.

This result confirmed the overall P dynamics in the soil plant system is a function of the integrative effects of P transformation, availability, and utilization caused by soil, rhizosphere, and plant processes.

HAP dissolution increases with decrease of soil pH (Wang and Nancollas, 2008), suggesting that rhizosphere acidification may be an efficient strategy to mobilize soil P from calcareous soil.

Values of fresh forage productivity as affected by the applied phosphorus, phosphorus promoters and some of their mixtures, and the way of application are listed below in the following set of data generated from Table (2). This is for the sake of easy comparisons:

Sulpher treatments	B.bean (ton/fed.)	F.cowpea (ton/fed.)	Phosphoric acid treatments	B.bean (ton/fed.)	F.cowpea (ton/fed.)
Sulpher (soil)	23.14	16.60	Phosphoric acid (soil)	23.47	16.13
Calcium super phosphate (soil)	21.93	15.80	Phosphoric acid (foliar)	21.40	14.13
Sulpher + Calcium super phosphate (soil)	23.33	16.40	Phosphoric acid (Soil +Foliar)	20.54	14.67
			Control	21.13	16.13

The interaction effect of indigenous-native legumes and phosphorus treatments on fresh forage yield was only significant for total fresh forage yield of the first season as well as for the combined analysis of the two seasons. However, results generally indicated that the highest fresh forage yield was obtained from B. bean with sulpher application (13.87 ton/fed) in the second cut. Whereas, the lowest forage yield was obtained from F.cowpea fertilized with calcium super phosphate (5.87 ton/fed) in the second cut (Table 2).

Seasonal variations exerted significant difference in fresh forage yield between the grown forage legumes (Table 2). Results indicated that the second season was higher than the first one for each of the grown forage legumes and phosphorus fertilization. Moreover, data showed that there were significant differences between the subsequent cuts. Whereas, it was observed that the second cut was generally higher than the first one for total fresh yield for B.bean. Meanwhile, opposite trend was noticed for F.cowpea. It looks to be true that the obtained specific significant differences in total fresh yield for each of the grown legumes was indeed due to their individual specific genetical make up that interacted differently with the prevailing climatic and edaphic conditions of this study in various specific patterns (Table 1).

It is well noticed calcium super phosphate fertilizer produced lower fresh forage yield as compared with sulpher (alone) and/or when sulpher (as a promoter) was added.

This result may confirm the role of sulpher as a promoting agent in releasing the treatment phosphorus with soil particles which reduce its availability for plants. So, the role of sulpher could be due to its formulation of the soil (by decreasing its alkalinity), giving more chance for the phosphorus of calcium super phosphate to be more available for the grown forage plants. Moreover, there was no specific trend for the effect of sulpher addition whether applied alone or with calcium super phosphate for either B.bean or F.cowpea.

It is obviously clear from the combined analysis that any of the applied treatments (sulpher, calcium super phosphate, sulpher+ calcium super phosphate, soil phosphoric acid, foliar phosphoric acid and phosphoric acid as soil+foliar application) significantly increased forage yield of either B.bean or f.cowpea as compared with the control.

Table 2: Fresh yield productivity of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	Total
		……………………(ton / fed.)……………………								
Bonavista bean	Without (Control)	8.00	10.00	18.00	10.80	13.47	24.27	9.40	11.73	21.13
	Sulpher	8.00	13.33	21.33	10.53	14.40	24.93	9.27	13.87	23.14
	Calcium super phosphate	7.60	9.60	17.20	12.27	14.40	26.67	9.93	12.00	21.93
	Sulpher+ Calcium super phosphate	8.93	13.33	22.26	11.47	12.93	24.40	10.20	13.13	23.33
	Phosphoric acid (soil)	9.47	14.00	23.47	11.07	12.40	23.47	10.27	13.20	23.47
	Phosphoric acid (foliar)	4.67	11.60	16.27	11.73	14.80	26.53	8.20	13.20	21.40
	Phosphoric acid (Soil +Foliar)	5.60	12.67	18.27	10.93	11.87	22.80	8.27	12.27	20.54
Mean		7.47	12.08	19.55	11.26	13.47	24.73	9.36	12.77	22.13
Fodder cow pea	Without (Control)	4.93	6.80	11.73	10.53	10.00	20.53	7.73	8.40	16.13
	Sulpher	8.00	4.27	12.27	11.73	9.20	20.93	9.87	6.73	16.60
	Calcium super phosphate	9.20	2.80	12.00	10.67	8.93	19.60	9.93	5.87	15.80
	Sulpher+ Calcium super phosphate	8.40	4.27	12.67	10.53	9.60	20.13	9.47	6.93	16.40
	Phosphoric acid (soil)	4.80	4.93	9.73	11.20	11.33	22.53	8.00	8.13	16.13
	Phosphoric acid (foliar)	4.80	3.33	8.13	10.67	9.47	20.14	7.73	6.40	14.13
	Phosphoric acid (Soil +Foliar)	5.60	4.27	9.87	10.00	9.47	19.47	7.80	6.87	14.67
Mean		6.53	4.38	10.91	10.76	9.71	20.47	8.65	7.05	15.70
Interaction	Without (Control)	6.47	8.40	14.87	10.67	11.73	22.40	8.57	10.07	18.64
	Sulpher	8.00	8.80	16.80	11.13	11.80	22.93	9.57	10.30	19.87
	Calcium super phosphate	8.40	6.20	14.60	11.47	11.67	23.14	9.93	8.93	18.86
	Sulpher+ Calcium super phosphate	8.67	8.80	17.47	11.00	11.27	22.27	9.83	10.03	19.86
	Phosphoric acid (soil)	7.13	9.47	16.60	11.13	11.87	23.00	9.13	10.67	19.80
	Phosphoric acid (foliar)	4.73	7.47	12.20	11.20	12.13	23.33	7.97	9.80	17.77
	Phosphoric acid (Soil +Foliar)	5.60	8.47	14.07	10.47	10.67	21.14	8.03	9.57	17.60
Mean		7.00	8.23	15.23	11.01	11.59	22.60	9.00	9.91	18.91
LSD at: 5% for:		V= 0.55 T= 0.76 VT= 1.08	V= 0.67 T= 1.32 VT= 1.87		N.S	V= 2.14		T= 0.68 Y= 0.69 Ty= 0.96 Vty=1.36	V= 0.72 Y= 0.72 Vy=1.02 Vty=1.79	

Dry forage yield:

It is clear from Table (3) that, the effect of sulpher or phosphoric acid on dry forage yield was more or less similar with slight various magnitudes.

Combined analysis (over the applied phosphorus and its promoters treatments), clarified that there was appreciable significant differences in dry forage yield between the studied forage legumes Bonavista bean was higher in dry forage production (3.29) than fodder cow pea (2.11 ton/fed). So, B.bean was of about 56% higher in dry yield as compared with F.cowpea.

Over the grown forage legumes, combined analysis revealed that there were significant differences among the different phosphorus sources. Dry yield productivity of soil application could be ranked in the following descending order: sulpher+calcium super phosphate $_{(2.90)}$ > sulpher $_{(2.88)}$ > calcium super phosphate $_{(2.64)}$, as compared with the control $_{(2.63\ ton/fed.)}$.

Sulpher as a phosphorus promoter or phosphoric acids as soil application produced the highest significant dry forage yield for either B.bean or F.cowpea (combined over the two growing seasons) compared to soil application of calcium super phosphate or sulpher + calcium super phosphate in soil application treatments.

Soil application of sulpher was of the highest phosphorus availibity promoter in dry forage production of B.bean and F.cowpea compared to the other two soil application (calcium super phosphate, sulpher+ calcium super phosphate). This result was noticed in fresh forage yield previously discussed. It could be real true that the strong action of sulpher is related to several essential functions for increasing the availability of phosphorus absorption and enhancing the metabolic functions of plants for growth and development. The dissolving and oxidation of sulpher in the soil forming sulphoric acid which in turn decrease the alkalinity of the soil which increase phosphorus availability for plants absorption. Moreover, sulpher mineral exerts its role as an important microelement.

Regarding phosphoric acid as a soil application, it produced the highest dry forage yield for either of the two forage crops (B.bean and F. cowpea). Similar trend was noticed for fresh forage yield previously presented. So, the superiority of soil application of phosphoric acid in promoting phosphorus.

Also, phosphoric acid application was soil phosphoric acid $_{(2.88)}$ > foliar phosphoric acid $_{(2.53)}$ > phosphoric acid in soil +foliar application $_{(2.46\ ton/fed)}$, whereas the control fertilization produced 2.63 ton/fed with significant differences among the subsequent order as it is clear from Table (3). Similar results were reported by Jain *et al*. (1986), Tenebe *et al*. (1995) and Sanginga *et al*. (2000) in Fodder cowpea.

The superiority of phosphoric acid treatments in fresh and dry yield production is related to the formulation of phosphorus in its components and the alkaline decrease (acidity) of the soil which are responsible for promoting the availability of the phosphorus in alkaline or calcareous soil.

Values of dry yield as affected by the applied phosphorus, phosphorus promoters and some of their mixtures, and the way of application are listed below in the following set of data generated from Table (2). This is for the sake of easy comparisons:

Sulpher treatments	B.bean (ton/fed.)	F.cowpea (ton/fed.)	Phosphoric acid treatments	B.bean (ton/fed.)	F.cowpea (ton/fed.)
Sulpher (soil)	3.64	2.10	Phosphoric acid (soil)	3.36	2.38
Calcium super phosphate (soil)	3.26	2.01	Phosphoric acid (foliar)	3.13	1.94
Sulpher+ Calcium super phosphate (soil)	3.51	2.29	Phosphoric acid (Soil +Foliar)	2.91	2.08
			Control	3.18	2.06

The interaction effect of the grown forage legumes, phosphorus and phosphorus promoting sources on dry forage yield was only significant for dry forage yield of the first cut of the first season and the second cut of the second season and for the combined analysis of the two seasons as well. However, results generally showed that the highest dry yield was obtained for B. bean with sulpher (2.47 ton/fed) in the second cut. Whereas, the lowest dry yield was obtained from F.cowpea of the control (0.71 ton/fed) in the first cut (Table 3).

Table 3: Dry yield of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Total	1st cut	2nd cut	Total	1st cut	2nd cut	1st cut
		……………………(ton / fed.)……………………								
Bonavista bean	Without (Control)	1.00	1.53	2.53	1.40	2.44	3.84	1.20	1.98	3.18
	Sulpher	1.09	2.30	3.39	1.25	2.64	3.89	1.17	2.47	3.64
	Calcium super phosphate	1.04	1.52	2.56	1.53	2.43	3.96	1.29	1.97	3.26
	Sulpher+ Calcium super phosphate	1.17	2.16	3.33	1.42	2.28	3.70	1.29	2.22	3.51
	Phosphoric acid (soil)	1.17	2.29	3.46	1.28	2.00	3.28	1.22	2.14	3.36
	Phosphoric acid (foliar)	0.62	1.71	2.33	1.36	2.56	3.92	0.99	2.14	3.13
	Phosphoric acid (Soil +Foliar)	0.64	2.06	2.70	1.24	1.87	3.11	0.94	1.97	2.91
Mean		0.96	1.94	2.90	1.36	2.32	3.68	1.16	2.13	3.29
Fodder cow pea	Without (Control)	0.56	0.99	1.55	0..86	1.70	1.70	0.71	1.35	2.06
	Sulpher	0.92	0.79	1.71	1.04	1.46	2.50	0.98	1.12	2.10
	Calcium super phosphate	0.97	0.44	1.41	1.13	1.49	2.62	1.05	0.96	2.01
	Sulpher+ Calcium super phosphate	0.94	0.93	1.87	1.05	1.67	2.72	0.99	1.30	2.29
	Phosphoric acid (soil)	0.57	0.88	1.45	1.04	2.26	3.30	0.81	1.57	2.38
	Phosphoric acid (foliar)	0.49	0.59	1.08	1.13	1.67	2.80	0.81	1.13	1.94
	Phosphoric acid (Soil +Foliar)	0.57	0.87	1.44	0.93	1.68	2.61	0.80	1.28	2.08
Mean		0.72	0.78	1.50	1.03	1.71	2.74	0.87	1.24	2.11
Interaction	Without (Control)	0.78	1.26	2.04	1.13	2.07	3.20	3.20	1.67	2.63
	Sulpher	1.01	1.54	2.55	1.15	2.05	3.20	3.20	1.80	2.88
	Calcium super phosphate	1.00	0.98	1.98	1.33	1.96	3.29	3.29	1.47	2.64
	Sulpher+ Calcium super phosphate	1.05	1.55	2.60	1.23	1.97	3.20	3.20	1.76	2.90
	Phosphoric acid (soil)	0.87	1.58	2.45	1.16	2.13	3.29	3.29	1.86	2.88
	Phosphoric acid (foliar)	0.55	1.15	1.70	1.24	2.11	3.35	3.35	1.63	2.53
	Phosphoric acid (Soil +Foliar)	0.60	1.46	2.06	1.09	1.78	2.87	2.87	1.62	2.46
Mean		0.84	1.36	2.20	1.19	2.01	3.20	1.01	1.69	2.70
LSD at: 5% for:		V= 0.05 T= 0.11 VT= 0.16	V= 0.12 T= 0.31		N.S	V= 0.27 VT= 0.33		T= 0.10 V= 0.09 Y= 0.09 Ty= 0.14	V= 0.10 Y= 0.10 Vy=0.14 Vty=0.38	

Seasonal variations exerted significant difference in dry yield between the studied forage legumes (Table 3). Results showed that the production of the second season was higher than the first cuts for each of the two forage legumes and for all of the phosphorus application treatments. Also, relatively there were significant differences between the subsequent cuts. Whereas, it was observed that the second cut was relatively higher than the first cuts of dry forage yield for B.bean and F.cowpea. It looks to be true that the obtained specific significant differences in dry yield for each of the grown legumes was indeed due to their individual specific genetical make up that interacted differently with the prevailing environmental conditions of this study in various specific patterns (Table 1).

The obtained increase of fresh and dry yield could be due to changing their root architecture, including root morphology, topology, and distribution patterns. Increases in root/shoot ratio, root branching, root elongation, root topsoil foraging, and root hairs are commonly observed in P-deficient plants, while the formation of specialized roots such as cluster roots occurs in a limited number of species (Lynch and Brown, 2008 and Vance, 2008). P deficiency enhance length and density of root hairs and lateral roots in many plant species, which all contributed in plant adaptation for phosphorus deficiency as reported by (Lo´pez-Bucio *et al.,* 2003; Desnos, 2008).

Vegetative growth behaviour:
Plant height:

Results clarified significant differences in plant heights between the grown forage legumes over the applied phosphorus and its promoter treatments (Table 4).

Over the applied phosphorus treatments, and on the average basis of the combined analysis, results indicated that B.bean was of the tallest plants (129.6) as compared with
F.cowpea (92.8 cm) with significant differences. Similar trend was noticed for the individual cuts and their average during the first and the second seasons with slight various magnitudes (Table 4). Such results reflect the specific genetical structure of each of the two grown forage legumes under study as affected by the prevailing climatic and edaphic environmental conditions (Table 1).

Plant heights of forage legumes were different due to the applied phosphorus and its promoter treatment sources (over the two forage legumes). Slight significant decrease in plant height was obtained especially when comparing between the control and phosphorus fertilization treatment sources. Whereas, the tallest plants were obtained for their control as compared with the other applied treatments. The respective descending order of soil application for the height of plants was for sulpher + calcium super phosphate $_{(115.1)}$ > calcium super phosphate $_{(113.3)}$ > sulpher $_{(111.8\ cm)}$, as compared with the control $_{(119.6\ cm)}$ with significant differences.

Table 4: Plant height of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
		……………………(Cm)……………………								
Bonavista bean	Without (Control)	92.3	197.3	144.8	83.3	170.7	127.0	87.8	184.0	135.9
	Sulpher	93.3	185.7	139.5	86.0	195.3	140.6	89.7	190.5	140.1
	Calcium super phosphate	116.0	146.7	131.3	95.7	166.0	130.8	105.8	156.3	131.0
	Sulpher+ Calcium super phosphate	115.7	169.3	142.5	82.7	168.0	125.3	99.2	168.7	133.9
	Phosphoric acid (soil)	108.0	150.0	129.0	80.7	176.0	128.3	94.3	163.0	128.6
	Phosphoric acid (foliar)	108.0	141.0	124.5	88.0	154.7	121.3	98.3	147.8	123.0
	Phosphoric acid (Soil +Foliar)	93.7	140.0	116.8	75.0	149.3	112.1	84.3	144.7	114.5
Mean		103.9	161.4	132.6	84.5	168.6	126.5	94.2	165.0	129.6
Fodder cow pea	Without (Control)	110.3	114.0	112.1	87.0	102.0	94.5	98.7	108.0	103.3
	Sulpher	86.0	72.0	79.0	91.3	85.0	88.1	88.7	78.5	83.6
	Calcium super phosphate	86.3	78.0	82.1	97.7	120.7	109.2	92.0	99.3	95.6
	Sulpher+ Calcium super phosphate	99.0	61.0	80.0	81.3	144.0	112.6	90.2	102.5	96.3
	Phosphoric acid (soil)	100.0	73.3	86.6	98.3	80.3	89.3	99.2	76.8	88.0
	Phosphoric acid (foliar)	87.7	77.7	82.7	124.0	153.7	138.8	105.8	115.7	110.7
	Phosphoric acid (Soil +Foliar)	74.7	56.0	65.3	85.0	72.3	78.65	79.8	64.2	72.0
Mean		92.0	76.0	84.0	95.0	108.3	101.6	93.5	92.1	92.8
Interaction	Without (Control)	101.3	155.7	128.5	85.2	136.3	110.7	93.2	146.0	119.6
	Sulpher	89.7	128.8	109.2	88.7	140.2	114.4	89.2	134.5	111.8
	Calcium super phosphate	101.2	112.3	106.7	96.7	143.3	120.0	98.9	127.8	113.3
	Sulpher+ Calcium super phosphate	107.3	115.2	111.2	82.0	156.0	119.0	94.7	135.6	115.1
	Phosphoric acid (soil)	104.0	111.7	107.8	89.5	128.2	108.8	96.7	119.9	108.3
	Phosphoric acid (foliar)	98.2	109.3	103.7	106.0	154.2	130.1	102.1	131.7	116.9
	Phosphoric acid (Soil +Foliar)	84.2	98.0	91.1	80.0	110.8	95.4	82.1	104.4	93.2
Mean		98.0	118.7	108.3	89.7	138.4	114.1	93.8	128.5	111.2
LSD at: 5% for:		T= 7.29 VT=10.30	V=19.25 T= 9.10 VT= 12.87		T= 11.80	V=18.16 T= 12.29 VT= 17.38		T= 6.75 V= 7.27 Ty=9.54 Vy=10.28 Vty=13.50	T= 7.44 V=8.54 Vt= 10.52 Y= 8.54 Ty= 7.44 Vy=12.07 Vty=14.88	

Foliar application of phosphoric acid produced the tallest plants $_{(116.9)}$ with a descending decrease of soil phosphoric acid $_{(108.3)}$ > phosphoric acid in soil +foliar application $_{(93.2\ cm)}$, whereas the control was of the tallest plants $_{(119.6\ cm)}$ with significant differences along the presented subsequent order. Similar trend was noticed for each of the individual cuts and their averages for the first and second seasons and their combined analysis as well with relatively various magnitudes. Similar trend were noticed and reported by Jilani *et al.* (2001) in lablab

The significant interaction effects of the applied phosphorus and its promoter factors on the height of plants generally indicated that B.bean was of the tallest plants when using soil sulpher application, whereas, F.cowpea was of the shortest plants receiving phosphoric acid in splitted application (soil +foliar). Other interactions effects for the applied factors on the height of plants were recorded in Table (4).

Leaf / stem ratio of plants:

Results in Table (5) showed the effect of phosphorus application and its promoter treatments on leaf/stem ratio of the studied forage legumes. Over the combined analysis, leaf/stem ratio of the grown fodder legumes showed slight significant differences with narrow range of slight various magnitudes. Whereas, B.bean was higher (1.15cm) than F. cowpea (1.09cm). This trend was generally noticed for the individual cuts and their average for each of the two seasons. Such obtained behavior of leaf/stem ratio was almost similar in the cuts within slight fluctuated ignorable magnitudes (Table, 5).

However, it is noticed that differences in leaf/stem ratio were slightly varied but indicated almost similar trend. It could be generally noticed that leaf / stem ratio is very specific feature for each specific forage legumes which definitely depends on the unique genetic makeup and the prevailing environmental conditions.

Table 5: Leaf: Stem ratio of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
		……………………(on fresh weight basis)……………………								
Bonavista bean	Without (Control)	1.30	1.00	1.15	1.41	0.63	1.02	1.35	0.81	1.08
	Sulpher	1.34	0.99	1.16	1.48	0.46	0.97	1.41	0.73	1.07
	Calcium super phosphate	1.00	1.37	1.18	1.47	0.43	0.95	1.24	0.90	1.07
	Sulpher+ Calcium super phosphate	1.24	1.50	1.37	1.49	0.66	1.07	1.36	1.08	1.22
	Phosphoric acid (soil)	0.90	1.23	1.06	1.96	0.51	1.23	1.43	1.05	1.24
	Phosphoric acid (foliar)	1.45	0.78	1.11	1.04	0.43	0.73	1.24	0.83	1.03
	Phosphoric acid (Soil +Foliar)	1.50	0.90	1.20	1.85	1.28	1.56	1.68	1.03	1.35
Mean		1.25	1.21	1.23	1.53	0.63	1.08	1.39	0.92	1.15
Fodder cow pea	Without (Control)	1.39	0.89	1.14	1.49	0.74	1.11	1.44	0.82	1.13
	Sulpher	1.88	0.89	1.38	1.20	0.73	0.96	1.54	0.81	1.17
	Calcium super phosphate	1.08	0.45	0.76	1.73	0.91	1.32	1.41	0.68	1.04
	Sulpher+ Calcium super phosphate	1.85	0.45	1.15	1.33	0.43	0.88	1.59	0.44	1.01
	Phosphoric acid (soil)	1.69	0.47	1.08	1.86	0.78	1.32	1.77	0.62	1.19
	Phosphoric acid (foliar)	1.61	0.73	1.17	1.38	0.64	1.01	1.50	0.68	1.09
	Phosphoric acid (Soil +Foliar)	1.18	0.67	0.92	1.29	0.83	1.06	1.23	0.75	0.99
Mean		1.53	0.65	1.09	1.47	0.72	1.09	1.50	0.69	1.09
Interaction	Without (Control)	1.34	0.95	1.14	1.45	0.68	1.06	1.40	0.81	1.10
	Sulpher	1.61	0.94	1.27	1.34	0.59	0.96	1.48	0.77	1.12
	Calcium super phosphate	1.04	0.91	0.95	1.6	0.67	1.13	1.32	0.79	1.05
	Sulpher+ Calcium super phosphate	1.55	0.98	1.26	1.41	0.54	0.97	1.48	0.76	1.12
	Phosphoric acid (soil)	1.29	1.03	1.16	1.91	0.65	1.28	1.60	0.84	1.22
	Phosphoric acid (foliar)	1.53	0.98	1.25	1.21	0.54	0.87	1.37	0.76	1.06
	Phosphoric acid (Soil +Foliar)	1.34	0.72	1.03	1.57	1.06	1.31	1.46	0.89	1.17
Mean		1.38	0.93	1.16	1.50	0.67	1.09	1.44	0.80	1.12
LSD at: 5% for:		V= 0.17 T= 0.16 VT= 0.22	V= 0.08 VT= 0.26		T= 0.17 VT= 0.24	T= 0.10 VT= 0.14		T= 0.11 V= 0.07 Vt= 0.16 Y= 0.07 Ty= 0.16 Vy=0.10 Vty= 0.23	V= 0.04 Vt= 0.14 Y= 0.04 Ty= 0.14 Vy=0.06 Vty= 0.20	

Combined over the grown two legumes, results indicated slight tendency for increasing leaf/stem ratio of forage legumes according the applied phosphorus application.

Leaf/stem ratio could be ranked in the following descending order for soil application of sulpher $_{(112)}$ = sulpher+ calcium super phosphate $_{(1.12)}$ > calcium super phosphate $_{(1.05 \text{ on fresh weight basis})}$, as compared with the control $_{(1.10 \text{ on fresh weight basis})}$.

Regarding phosphoric acid, leaf/stem ratio of plants were decreased respectively according to the respective phosphorus treatments as follows: soil applications of phosphoric acid $_{(1.22)}$ > phosphoric acid splitted into soil and foliar application $_{(1.17)}$ > foliar phosphoric acid $_{(1.06 \text{ on fresh weight basis})}$, whereas the control treatment was $_{(1.10 \text{ on fresh weight basis})}$ as it is presented in Table (5). Similar comparative studies were conducted by Foster *et al.* (2009) in Fodder cowpea.

Concerning interaction effect, significant effect of the tested legumes x phosphorus application treatments on leaf / stem ratio of plants which showed slight significant differences during the two seasons and their combined analysis as well as for the individual cuts of the two seasons except for the second cut of the first season.

Number of shoots / m^2:

Combined analysis over the applied phosphorus treatments indicated significant differences between the two studied legumes in their number of shoots/m^2 as shown in Table (6).

Over the applied phosphorus and its promoter, combined analysis revealed appreciable significant differences in number of shoot/m^2 between the studied forage legumes. Fodder cow pea was higher number of shoot/m^2 (14.52) than Bonavista bean (9.62 shoots/m^2). So, F.cowpea was of about 51% higher in number of shoot/m^2as compared B.bean (Table 6).

Over the grown forage legumes, the combined analysis clarified that there was significant differences for phosphorus treatments on the number of shoot/m^2 of soil application which could be ranked in the following descending order: sulpher+calcium super phosphate $_{(13.17)}$, sulpher $_{(12.50)}$ and calcium super phosphate $_{(12.50\ shoots/m^2)}$, as compared with control $_{(11.66\ shoots/m2)}$.

Concerning, phosphoric acid application**,** phosphoric acid splitted into soil +foliar produced $_{(12.33)}$, which was not varied much more foliar phosphoric application $_{(12.16)}$, with clear decrease in this studied trait for soil application of phosphoric acid $_{(10.17\ shoots/m^2)}$, while the control was of 11.66 shoots/m^2 as it is clear from Table (6). This trend was generally noticed on the basis of the individual cuts and their average for each of the two seasons with slight fluctuated ignorable magnitudes (Table, 6).

The interaction effect of the two grown legumes and phosphorus treatments on number of shoot/$m^2$was significant only for the number of shoot/m^2 in the first season as well as for the combined analysis of the two seasons. However, results generally indicated that the highest number of shoot/$m^2$was obtained from F.cowpea with soil phosphoric acid application $_{(18.00\ shoots/m^2)}$ in the first cut. Meanwhile, the lowest number of shoot/$m^2$was obtained from B. bean fertilized with calcium super phosphate $_{(6.00\ shoots/m^2)}$ in the first cut (Table 6).

Table 6: Number of shoots/m^2 of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
		……………………(# of shoots/m2)……………………								
Bonavista bean	Without (Control)	12.00	10.67	11.33	8.00	9.33	8.66	10.00	10.00	10.00
	Sulpher	10.67	8.00	9.33	12.00	6.67	9.33	11.33	7.33	9.33
	Calcium super phosphate	10.67	5.33	8.00	13.33	9.33	11.33	12.00	7.33	9.66
	Sulpher+ Calcium super phosphate	9.33	8.00	8.66	12.00	9.33	10.66	10.67	8.67	9.67
	Phosphoric acid (soil)	5.33	5.33	5.33	6.67	10.67	8.67	6.00	8.00	7.00
	Phosphoric acid (foliar)	12.00	9.33	10.66	9.33	9.33	9.33	10.67	9.33	10.00
	Phosphoric acid (Soil +Foliar)	17.33	12.00	14.66	10.67	6.67	8.67	14.00	9.33	11.66
Mean		11.05	8.38	9.71	10.29	8.76	9.52	10.67	8.57	9.62
Fodder cow pea	Without (Control)	13.33	12.00	12.66	16.00	12.00	14.00	14.67	12.00	13.33
	Sulpher	21.33	16.00	18.66	14.67	10.67	12.67	18.00	13.33	15.66
	Calcium super phosphate	16.00	18.67	17.33	16.00	10.67	13.33	16.00	14.67	15.33
	Sulpher+ Calcium super phosphate	16.00	20.00	18.00	17.33	13.33	15.33	16.67	16.67	16.67
	Phosphoric acid (soil)	17.33	14.67	16.00	13.33	8.00	10.66	15.33	11.33	13.33
	Phosphoric acid (foliar)	16.00	20.00	18.00	12.00	9.33	10.66	14.00	14.67	14.33
	Phosphoric acid (Soil +Foliar)	10.67	14.67	12.67	12.00	14.67	13.33	11.33	14.67	13.00
	Mean	15.81	16.57	16.19	14.48	11.24	12.86	15.14	13.90	14.52
Interaction	Without (Control)	12.67	11.33	12.00	12.00	10.67	11.33	12.33	11.00	11.66
	Sulpher	16.00	12.00	14.00	13.33	8.67	11.00	14.67	10.33	12.50
	Calcium super phosphate	13.33	12.00	12.66	14.67	10.00	12.33	14.00	11.00	12.50
	Sulpher+ Calcium super phosphate	12.67	14.00	13.33	14.67	11.33	13.00	13.67	12.67	13.17
	Phosphoric acid (soil)	11.33	10.00	10.66	10.00	9.33	9.66	10.67	9.67	10.17
	Phosphoric acid (foliar)	14.00	14.67	14.33	10.67	9.33	10.00	12.33	12.00	12.16
	Phosphoric acid (Soil +Foliar)	14.00	13.33	13.66	11.33	10.67	11.00	12.67	12.00	12.33
Mean		13.42	12.47	12.95	12.38	10.00	11.19	12.90	11.23	12.07
LSD at: 5% for:		V= 1.16 VT= 3.61	V= 0.58 T= 1.68 VT= 2.38		V= 2.09	N.S		T= 1.75 V= 0.77 Y= 0.77 Vt= 0.79 Vty= 3.49	V= 1.15 Y= 1.15 Vy=1.63 Vty=3.00	

Crude protein (CP) content:

Results in Table (7) showed slight significant differences in Crude protein (CP) between the two grown forage legumes over the applied phosphorus treatments

Over the applied phosphorus fertilization and their promoters. It is generally noticed that F.cowpea contained slightly higher crude protein content than B.bean. this result was true in each cut of each of the two growing seasons and their combined analysis as well as it is clear from Table (7). However, differences are not great enough to be considered. In other words, the F.cowpea was relatively higher in CP content (25.01) as compared with B.bean (24.42%) with slight significant differences in between. Similar trend was noticed during the individual cuts and their means during the first and the second seasons with slight magnitudes (Table 7). Such results may reflect the specific genetical structure of each of the grown forage legumes under study in such plant features as affected by the prevailing environmental conditions (Table 1).

Crude protein (CP) content of forage legumes showed significant differences among applied phosphorus treatments sources (over the two forage legumes). Significant increase in CP content was obtained especially when comparing between the control and application of phosphorus treatment sources. The respective descending order in crude protein content for soil application was sulpher+calcium super phosphate $_{(25.74)}$ > sulpher $_{(25.34)}$ > calcium super phosphate $_{(25.12\ \%)}$, as compared to their control $_{(23.90\ \%)}$.

Along the same line, soil phosphoric acid application $_{(24.67)}$ > foliar phosphoric acid $_{(24.23)}$ > phosphoric acid splitted into soil +foliar application $_{(23.99\ \%)}$ as compared with the control which was 23.90 %, with significant differences among the subsequent order. Similar trend was noticed for each of the individual cuts and their means for the first and second seasons and their combined analysis as well with almost slight similar magnitudes (Table 7). Relatively similar results were reported by Mokoboki *et al.* (2000) for cowpea, Jilani *et al*. (2001) and Odunsi (2003) for lablab.

The significant interaction effects of the applied phosphorus and its promoters treatments on CP content generally indicate that F.cowpea was of the richest plants in CP content fertilized with calcium super phosphate (28.52%), whereas, B.bean was of the lowest
CP content (20.98%) for the control. The other interactions effects for the applied phosphorus fertilization and promoter treatments on CP content were recorded in Table (7).

Table 7: Crude protein (CP) content of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
		……………………(%)……………………								
Bonavista bean	Without (Control)	24.98	23.46	24.22	21.87	18.50	20.18	23.43	20.98	22.20
	Sulpher	25.73	24.96	25.34	25.75	21.87	23.81	25.74	23.42	24.58
	Calcium super phosphate	25.21	24.40	24.80	23.96	22.58	23.27	24.58	23.49	24.03
	Sulpher+ Calcium super phosphate	28.02	26.29	27.15	25.58	25.69	25.63	26.80	25.98	26.39
	Phosphoric acid (soil)	27.96	26.50	27.23	21.37	20.31	20.84	24.67	23.41	24.04
	Phosphoric acid (foliar)	24.94	23.94	24.44	25.58	24.96	25.27	25.26	24.45	24.85
	Phosphoric acid (Soil +Foliar)	25.12	24.19	24.65	26.63	23.50	25.06	25.88	23.84	24.86
Mean		25.99	24.82	25.40	24.39	22.49	23.44	25.19	23.65	24.42
Fodder cow pea	Without (Control)	26.10	25.29	25.69	28.33	22.65	25.49	27.22	23.97	25.59
	Sulpher	28.42	25.71	27.06	28.56	21.75	25.15	28.49	23.73	26.11
	Calcium super phosphate	28.75	26.19	27.47	28.29	21.58	24.93	28.52	23.88	26.20
	Sulpher+ Calcium super phosphate	28.15	26.33	27.24	24.06	21.87	22.96	26.10	24.10	25.10
	Phosphoric acid (soil)	26.63	23.15	24.89	27.06	24.42	25.74	26.85	23.78	25.31
	Phosphoric acid (foliar)	27.52	25.08	26.3	20.60	21.25	20.92	24.06	23.17	23.61
	Phosphoric acid (Soil +Foliar)	27.29	24.46	25.87	21.77	19.00	20.38	24.53	21.73	23.13
Mean		27.55	25.17	26.36	25.53	21.79	23.66	26.54	23.48	25.01
Interaction	Without (Control)	25.54	24.38	24.96	25.11	20.57	22.84	25.32	22.48	23.90
	Sulpher	27.07	25.33	26.20	27.16	21.81	24.48	27.11	23.57	25.34
	Calcium super phosphate	26.98	25.29	26.13	26.13	22.08	24.10	26.55	23.69	25.12
	Sulpher+ Calcium super phosphate	28.08	26.31	27.19	24.82	23.77	24.29	26.45	25.04	25.74
	Phosphoric acid (soil)	27.29	24.82	26.05	24.22	22.37	23.29	25.76	23.59	24.67
	Phosphoric acid (foliar)	26.23	24.51	25.37	23.09	23.10	23.09	24.66	23.81	24.23
	Phosphoric acid (Soil +Foliar)	26.21	24.32	25.26	24.20	21.25	22.72	25.20	22.79	23.99
Mean		26.77	24.99	25.88	24.96	22.13	23.54	25.86	23.56	24.71
LSD at: 5% for:		N.S	VT= 1.36		T= 1.25 VT= 1.77	T= 1.13 VT= 1.60		T= 0.93 V= 0.99 Vt= 1.31 Y= 0.99 Ty= 1.31 Vy=1.40 Vty=1.86	T= 0.72 V= 0.38 Vt= 1.02 Y= 0.38 Vy=0.54 Vty=1.44	

Crude fiber (CF) content:

Over the applied phosphorus and its promoter treatments, combined analysis indicated slight significant variations in CF content between the two grown leguminous forages inspite of the very narrow close ranges in between, which could be almost similar and of no specific trend as it is clear in Table (8). These results were almost true for each cut of each growing season, and their combined analysis as well.

The combined analysis showed almost similar magnitudes between the two studied forage legumes. Whereas, B.bean produced CF content of 30.60% and F.cowpea was 30.26% with inspit of the slight significant differences in between. Similar trend was noticed for the individual cuts and their average during the first and the second seasons with slight various magnitudes (Table, 8).

Over the two grown forage legumes, data of the combined analysis showed that crude fiber (CF) content of forage legumes were of significant differences among phosphorus treatment and its promoter sources. The values of CF for soil application of sulpher could be ranked in the following descending order: calcium super phosphate (31.50) > sulpher+calcium super phosphate (30.68) > sulpher (29.93 %), as compared to the control (30.05 %).

Also, phosphoric acid in soil applications produced higher CF content (30.72) than its foliar application (30.16), then the splitted soil +foliar application (29.98 %), and their control was of 30.05 % CF, with significant differences. Similar trend was noticed for each of the individual cuts and their averages for the first and second seasons and their combined analysis as well with slight magnitudes (Table 8).Similar results were reported by Odunsi (2003) for lablab and Foster *et al.* (2009) for soybean and cowpea.

The interaction effect of the applied phosphorus sources and its promoters on CF content generally indicated that F.cowpea type was of the highest plants in CF content with calcium super phosphate fertilization (33.45%) in the second cut. Meanwhile, B.bean type was of the lowest CF content (27.94%) with phosphoric acid splitted (Soil +Foliar) application.

Table 8: Crude fiber (CF) content of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
		……………………(%)……………………								
Bonavista bean	Without (Control)	29.20	30.84	30.02	29.86	31.99	30.92	29.53	31.41	30.47
	Sulpher	27.93	29.60	28.76	28.57	31.20	29.88	28.25	30.40	29.32
	Calcium super phosphate	31.34	32.34	31.84	28.36	31.83	30.09	29.85	32.09	30.97
	Sulpher+ Calcium super phosphate	30.53	30.89	30.71	31.66	33.01	32.33	31.09	31.95	31.52
	Phosphoric acid (soil)	30.38	31.31	30.84	31.28	33.06	32.17	30.83	32.18	31.50
	Phosphoric acid (foliar)	31.24	33.94	32.59	26.84	32.20	29.52	29.04	33.07	31.05
	Phosphoric acid (Soil +Foliar)	27.21	29.01	28.11	28.68	32.57	30.62	27.94	30.79	29.36
Mean		29.69	31.13	30.41	29.32	32.26	30.79	29.51	31.70	30.60
Fodder cow pea	Without (Control)	26.91	30.59	28.75	29.46	31.60	30.53	28.19	31.09	29.64
	Sulpher	28.83	29.80	29.31	29.53	34.03	31.78	29.18	31.91	30.54
	Calcium super phosphate	30.20	33.96	32.08	31.07	32.94	32.00	30.64	33.45	32.04
	Sulpher+ Calcium super phosphate	27.27	28.66	27.96	29.88	33.56	31.72	28.57	31.11	29.84
	Phosphoric acid (soil)	28.94	30.66	29.8	28.97	31.17	30.07	28.95	30.91	29.93
	Phosphoric acid (foliar)	26.60	29.08	27.84	30.27	31.11	30.69	28.43	30.10	29.26
	Phosphoric acid (Soil +Foliar)	28.81	32.53	30.67	30.24	30.80	30.52	29.52	31.67	30.59
Mean		28.22	30.75	29.48	29.92	32.17	31.04	29.07	31.46	30.26
Interaction	Without (Control)	28.06	30.71	29.38	29.66	31.79	30.72	28.86	31.25	30.05
	Sulpher	28.38	29.70	29.04	29.05	32.61	30.83	28.71	31.16	29.93
	Calcium super phosphate	30.77	33.15	31.96	29.72	32.38	31.05	30.24	32.77	31.50
	Sulpher+ Calcium super phosphate	28.90	29.78	29.34	30.77	33.28	32.02	29.83	31.53	30.68
	Phosphoric acid (soil)	29.66	30.98	30.32	30.12	32.11	31.11	29.89	31.55	30.72
	Phosphoric acid (foliar)	28.92	31.51	30.21	28.55	31.66	30.10	28.74	31.58	30.16
	Phosphoric acid (Soil +Foliar)	28.01	30.77	29.39	29.46	31.68	30.57	28.73	31.23	29.98
Mean		28.95	30.94	29.95	29.61	32.21	30.91	29.28	31.58	30.43
LSD at: 5% for:		V= 0.80 T= 1.19 VT= 1.68	T= 1.05 VT= 1.49		T= 0.75 VT= 1.06	VT= 1.04		T= 0.68 V= 0.33 Vt= 0.97 Y= 0.33 Ty= 0.97 Vy=0.46 Vty= 1.37	T= 0.71 Vt= 1.00 Y= 0.75 Ty= 1.00 Vty=1.42	

Phosphorus content:

Combined analysis in Table (9) present the effect of phosphorus and its promoters application sources on Phosphorus content of the studied forage legumes. Results showed that, Phosphorus content of the grown varieties caused slight significant differences within a very narrow range. Whereas, B.bean (3.75%) was of higher phosphorus than F.cowpea (3.53%) in phosphorus content. This trend was generally noticed on the basis of the individual cuts of the second season and their average for each of the two studied seasons. Such obtained behavior of Phosphorus content was slightly similar for the various cuts (Table, 9).

In this respect, it is generally noticed that over the obtained significant differences in phosphorus content which were slightly varied but indicating similar trend. It could be generally noticed that phosphorus content is very specific feature for each specific forage legumes types.

Phosphorus and its promoter contents over the two grown plants (B.bean and F. cowpea) were decreased in a descending order for the following corresponding phosphorus and its promoter treatments as follows: calcium super phosphate $_{(4.30)}$ > sulpher $_{(3.60)}$ > splitted sulpher+calcium super phosphate $_{(3.46\%)}$, and phosphoric acid application was for splitted phosphoric acid soil +foliar application $_{(3.87)}$ > soil application phosphoric acid $_{(3.31)}$ > foliar application phosphoric acid $_{(3.24\%)}$, as compared with control $_{(3.72\ \%)}$ with significant differences among the subsequent presented descending order. Similar trend was noticed for each of the individual cuts and their averages for the first and second seasons and their combined analysis as well with almost slight similar magnitudes (Table 9). Studies were conducted by Holford (1997) and Brynes and Bumb (1998) for cowpea in this respect.

Regarding the interaction significant effect of the tested legumes (B.bean and F. cowpea) x phosphorus application and its promoter sources on phosphorus content of plants clarified slight significant differences during the two seasons and their combined analysis as well as for the individual cuts of the two seasons (Table 9).

Table 9: Phosphorus (P) content of the studied forage legumes as affected by phosphorus application and its promoters.

Treatments		First summer season (2011)			Second summer season (2012)			Combined (over growing seasons)		
		1st cut	2nd cut	Mean	1st cut	2nd cut	Mean	1st cut	2nd cut	Mean
		……………………(%)……………………								
Bonavista bean	Without (Control)	4.03	3.25	3.64	4.59	4.31	4.45	4.31	3.78	4.04
	Sulpher	3.76	3.15	3.45	3.99	2.24	3.11	3.88	2.69	3.28
	Calcium super phosphate	3.96	4.33	4.14	4.79	4.47	4.63	4.37	4.40	4.38
	Sulpher+ Calcium super phosphate	3.34	2.97	3.15	4.20	4.43	4.31	3.77	3.70	3.73
	Phosphoric acid (soil)	3.40	3.01	3.20	3.87	4.06	3.96	3.63	3.53	3.58
	Phosphoric acid (foliar)	2.97	4.03	3.50	4.21	2.46	3.33	3.59	3.24	3.41
	Phosphoric acid (Soil +Foliar)	4.85	2.67	3.76	4.97	2.85	3.91	4.91	2.76	3.83
Mean		3.76	3.34	3.55	4.37	3.55	3.96	4.07	3.44	3.75
Fodder cow pea	Without (Control)	4.61	2.68	3.64	4.13	2.17	3.15	4.37	2.42	3.39
	Sulpher	6.12	3.26	4.69	3.85	2.45	3.15	4.98	2.85	3.91
	Calcium super phosphate	5.70	4.97	5.33	3.80	2.40	3.10	4.75	3.68	4.21
	Sulpher+ Calcium super phosphate	3.84	2.75	3.29	3.51	2.69	3.10	3.67	2.72	3.19
	Phosphoric acid (soil)	2.91	2.81	2.86	3.79	2.69	3.24	3.35	2.75	3.05
	Phosphoric acid (foliar)	3.27	3.43	3.35	2.88	2.69	2.78	3.07	3.06	3.06
	Phosphoric acid (Soil +Foliar)	4.30	4.63	4.46	3.99	2.70	3.34	4.14	3.66	3.90
Mean		4.39	3.50	3.94	3.71	2.54	3.12	4.05	3.02	3.53
Interaction	Without (Control)	4.32	2.96	3.64	4.36	3.24	3.80	4.34	3.10	3.72
	Sulpher	4.94	3.20	4.07	3.92	2.34	3.13	4.43	2.77	3.60
	Calcium super phosphate	4.83	4.65	4.74	4.29	3.44	3.86	4.56	4.04	4.30
	Sulpher+ Calcium super phosphate	3.59	2.86	3.22	3.85	3.56	3.70	3.72	3.21	3.46
	Phosphoric acid (soil)	3.16	2.91	3.03	3.83	3.38	3.60	3.49	3.14	3.31
	Phosphoric acid (foliar)	3.12	3.73	3.42	3.54	2.57	3.05	3.33	3.15	3.24
	Phosphoric acid (Soil +Foliar)	4.57	3.65	4.11	4.48	2.77	3.62	4.53	3.21	3.87
Mean		4.07	3.42	3.74	4.04	3.04	3.54	4.05	3.23	3.64
LSD at: 5% for:		V= 0.13 T= 0.12 VT= 0.18	V= 0.03 T= 0.02 VT= 0.02		V= 0.03 T= 0.03 VT= 0.05	V= 0.0006 T= 0.001 VT= 0.01		T= 0.06 V= 0.04 Vt= 0.09 Ty= 0.09 Vy= 0.06 Vty= 0.13	T= 0.009 V= 0.009 Vt= 0.01 Y= 0.009 Ty= 0.01 Vy=0.01 Vty= 0.02	

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