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EFFECT OF POTASSIUM AND BORON FERTILIZATION ON SEED YIELD AND ITS ATTRIBUTING CHARACTERS IN BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.)

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SUMMARY

As berseem seed yield is responsive to potassium and boron fertilization and their interaction, so in order to find out their effect and relationship, a field experiment was conducted during *rabi* season of 2017-18 at Forage Research Farm of CCS Haryana Agricultural University, Hisar. Treatment combinations comprised of four potassium levels *i. e.* 0, 20, 40 and 60 kg K_2O/ha and four levels of boron *i.e.* 0, 2, 4 kg B /ha, and 0.2% B spray at flower initiation and at 50% flowering stage. The experiment was laid out in split plot design and replicated thrice. Maximum number of capsules/m^2 (328.10), seeds/capsule (56.43), biological yield (49.91 q/ha) and seed yield (3.43 q/ha) were recorded at 60 kg K2O/ha which were significant higher than control and 20 kg K_2O/ha. Number of capsules/m^2 increased with increasing levels of boron over lower levels and the highest number of capsules/m^2 (338.40), seeds/capsule (56.12), test weight, biological yield (50.81 q/ha) and seed yield (3.63 q/ha) were recorded with foliar spray of boron @ 0.2% spray at flower initiation and at 50% flowering stage. Interaction effect of potassium and boron was also found significant with the combination of 40 kg K_2O/ha and 0.2% B spray at initiation and at 50% flowering over control which resulted in maximum number of capsules/m^2 and seeds/capsule.

Key words : Berseem, potassium levels, boron fertilization, seed yield

Berseem is an important crop of winter season and is popular for both milch and draught animals. Berseem provides green fodder for prolonged period of time i.e. from November to May in 4-5 cuts with green fodder yield of about 70 - 75 t/ha. It is a very nutritious, succulent, palatable and high yielding valuable leguminous crop. It is originated from Asia Minor and Egypt and is a diploid species belongs to family "Fabaceae" and genus "*Trifolium*". It requires mild summer, as well as, mild winter to grow well.

It is also moderately tolerant to salinity and can grow on a wide range of soils, though it prefers fertile, loamy to clay soils with mildly acidic to slightly alkaline pH *i.e.* 6.5-8 (Hackney *et al*., 2007). It also contributes to soil fertility by fixing the atmospheric nitrogen ranged from 272 to 400 kg N/ha, which results in the economy of fertilizer use for the next crop in the rotation and also improve soil physical characteristics (Graves *et al.*,1996). Because of high yielding nature, it is grown over the vast area and its seed has huge demand in the market. The timely availability of seed to the farmers helps in timely sowing and realization of its full potential as fodder.

Berseem is a shy seeder or low seed producer (Hazra and Sinha., 1996). The less attention has been paid in India to its seed production because it is mainly cultivated for fodder (Hazra and Rekib, 1991). At present, 10,375 MT of berseem seed was imported in 2015-16 to fulfill the seed requirement for planting purposes (Vijay *et al*., 2017). Seed plays an important role in success of any crop and plays a vital role in enhancing and sustaining the food production. Commercial seed production requires healthy, dynamic and genetically pure seed. Berseem crop being cross pollinated in nature needs extra care and attention for its seed production. The difficulty in producing high seed yield in berseem can be due to limited bee activity leading to poor pollination, pollen sterility and post-fertilization abortion of developing seeds all contribute

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to poor seed setting (Pasumarty *et al.*, 1993). The successful production of seed along with fodder production is highly influenced by applied nutrients mainly by potassium, molybdenum and boron. Potassium plays an important role in the adaptation of cells to abiotic stresses through their effect on water uptake, root growth and thereby can help in normal functioning by inducing long term thermo-tolerance in the plant (Rab and Haq, 2012). Plant takes up K mostly in the exchangeable and solution form as K^+ ions. Maintenance of charge balance across the cell membranes, osmotic adjustment, water relations, stomatal regulation, enzyme activation and resistance against biotic and abiotic stresses are among established functions of K in plants (Wakeel *et al.*, 2011). Micronutrients play distinct and vital role in plant physiological and biochemical processes (Putra *et al.*, 2012). It has been observed by Saeed *et al.*, (2011) that berseem had better performance in terms of seed production when fertilized with 30 kg K/ha in irrigated areas of Peshawar valley. The demand of these micronutrients is increased at reproductive stages *i.e.* flowering and seed setting. So, a balanced supply of the nutrients is essential for optimum seed yield and quality which can be fed to crop by foliar spraying at specific stages. Boron (B), a non-metal micronutrient, is essential for normal growth and development of plants, including forages (Dunn *et al.*, 2005), its essentiality was first reported in 1933 (Warington, 1933). The primary function of B is undoubtedly its structural role in cell walls and the maintenance of plasma membrane functions (Wimmer and Eichert, 2013). Boron is absorbed as boric acid (H_3BO_3) and borate ($H_2BO_3^-$) by plants roots. The reproductive stage of plants is far more sensitive to B deficiency than the vegetative phase (Ahmad *et al.*, 2009). The rate of translocation and redistribution of assimilates to new growing points, particularly fruits, improved with adequate B nutrition (Hellal *et al.*, 2009).

So an understanding of optimum fertilization is essential for maximizing the quality seed production, also information regarding the effect of these two nutrients *i.e.* potassium and boron on seed of berseem is very scanty. Hence, keeping in view the above facts, the present study was planned with the objective to study effect of potassium and boron fertilization on seed yield and its attributing characters in berseem.

MATERIALS AND METHODS

The experiment was carried out at Forage Research Farm, Chaudhary Charan Singh Haryana Agricultural University, Hisar during *rabi* season of 2017-18. The physico-chemical properties observed and methods used for analysis of soil in field are presented in Table 1. The experiment was laid out in split plot design consisting of 16 treatment combinations with three replications. Potassium @ 0, 20, 40, 60 kg /ha was applied through murate of potash as basal dose in main plot. Boron as solubor (20%) @ 0, 2, 4 kg /ha and 0.2% foliar spray at flowering initiation and 50% flowering were kept in sub plots. The berseem variety HB1 was sown on 1st December, 2017 using seed rate of 25 kg/ha by broadcasting method.

Number of capsules/m^2 were counted before harvest of crop for seed by quadrat of 0.25 m^2 (0 .5m x 0.5m) which was put at three randomly selected places in each plot and mean number of capsule/m^2 area was calculated.

For counting number of seeds/capsule three randomly selected shoots (one capsule randomly from each shoot but of same age) were tagged at flowering stage in each plot. On maturity, these capsules were plucked and collected plot wise. Seed obtained after threshing these capsules by rubbing were counted treatment wise and recorded. The data thus obtained was expressed as number of seeds/capsule. For test

TABLE 1
Physico-chemical properties of soil

Particulars	Range	Values	Method used
pH	Slightly alkaline	7.8	pH meter with glass electrode in 1:2 Soil Water Suspension (Jackson, 1973)
EC (ds/m)	Non-saline	0.5	Conductivity Bridge Method (Richards, 1954)
Organic carbon (%)	Medium	0.45	Digestion Method (Walkley and Black, 1934)
Available nitrogen (kg/ha)	Low	141.7	Alkaline Permanganate Method (Subbiah and Asija, 1956)
Available phosphorus (kg/ha)	Medium	16.2	Olsen's Method (Olsen *et al.*, 1954)
Available potassium (kg/ha)	Medium	238.5	Flame Photometric Method (Jackson, 1973)
Available boron (mg/kg)	Medium	0.85	Hot water soluble Boron method (Berger and Troug,1939)

TABLE 2
Effect of potassium and boron on seed yield and its attributing characters

Treatments Potassium levels (kg/ha)	Seed yield attributing characters			Seed yield			
	Number of capsules/m²	Seeds/ capsule	Test weight weight (g)	Biological yield (q/ha)	Seed yield yield (q/ha)	Straw yield yield (q/ha)	Harvest index for seed (%)
0	314.33	49.86	2.65	46.81	3.16	43.65	6.79
20	317.15	51.78	2.69	47.19	3.29	43.90	7.01
40	325.94	55.04	2.72	49.03	3.39	45.64	6.91
60	328.10	56.43	2.73	49.91	3.43	46.48	6.91
S. Em±	2.87	0.44	0.09	0.52	0.05	0.51	0.04
C. D. (P=0.05)	8.83	1.09	NS	1.84	0.18	1.69	NS
Boron levels (kg/ha)							
0	303.04	50.34	2.60	46.58	3.14	43.44	6.74
2	316.91	52.75	2.70	47.97	3.29	44.68	6.90
4	327.84	53.88	2.72	47.83	3.30	44.53	6.86
0.2% spray at initiation of flowering and at 50% flowering	338.40	56.12	2.85	50.81	3.63	47.18	7.13
S. Em±	2.61	0.51	0.05	0.43	0.05	0.41	0.11
C. D. (P=0.05)	7.69	1.23	0.14	1.25	0.15	1.15	0.29

weight estimation, random sample of seeds was drawn from the produce of each plot and 1000 seeds were counted and weighed on the electrical balance in grams. After harvesting the crop, the total yield with seed was recorded plot wise. This is the biological yield. Thus the total produce (seed + stover) obtained was expressed as total biomass per plot and expressed in q/ha. After recording the sun dried weight of biological yield obtained from each plot, the seed were separated and weighed. Later on, seed yield per plot was calculated and converted into q/ha. After threshing of crop, the seed yield was subtracted from the total biological yield to obtain straw yield. Later on, straw yield per hectare was calculated. The harvest index was calculated by dividing the economic yield (seed) with the biological yield and multiplying by 100 (Donald and Hamblin, 1976). The raw data observed during the whole experiment, was statistically analysed to draw the valid differences among the treatments using OPSTAT software. The significant difference among treatments was tested by calculating critical difference (C.D.) at 5% level of significance.

RESULTS AND DISCUSSION

Application of graded doses of potassium increased the number of capsules/m^2 and seeds/capsule which were significantly higher with 60 kg K_2O /ha over control and 20 kg K_2O/ha. Number of capsules/m^2 and seeds/capsule significantly increased with increasing levels of boron over lower levels and the highest values were recorded with the foliar application of B @ 0.2% foliar spray at initiation and at 50% flowering (Table 2). It might be due to boron as it maintains the meristematic activity and is required for the synthesis of N-bases such as uracil (Albert, 1968), also boron is involved in synthesis of proteins, amino acids and transport of carbohydrate towards the sink. These results are in close agreement with the findings of Pivovarova (1985).

The data given in Table 3 further revealed that interaction effect of potassium and boron was also prominent and the combination of 40 kg K_2O/ha and 0.2% spray at initiation and at 50% flowering resulted in maximum number of capsules/m^2 (348.07). Interaction effect of potassium and boron was found significant with 0.2% spray at initiation and at 50% flowering and 40 kg K_2O/ha over control. This combination resulted in highest number of seeds/ capsule (58.73) as indicated in Table 4.

Potassium application had no significant effect on test weight. Whereas, different boron levels revealed significant effect with maximum test weight in treatment of 0.2% spray at initiation and 50% flowering over control (Table 2). An increasing trend in biological yield was noticed with the increasing levels of potassium and significant increase was observed with 60 kg K_2O/ha over control. With respect

TABLE 3
Interaction effect of potassium and boron on number of capsules m^{-2}

Treatments Potassium levels (kg/ha)	Boron levels (kg/ha) 0	2	4	0.2% spray at initiation of flowering and at 50% flowering	Mean	Source	S. Em±	C. D. (P=0.05)
0	294.04	309.75	324.93	328.28	314.33	Potassium	2.87	8.83
20	298.68	312.28	322.31	337.34	317.15	Boron	2.61	7.69
40	308.01	319.73	328.05	348.07	325.94	K x B	5.52	16.43
60	311.33	325.04	335.97	340.01	328.10	B x K	5.34	16.57
Mean	303.04	316.91	327.84	338.40				

TABLE 4
Interaction effect of potassium and boron on number of seeds/capsule

Treatments Potassium levels (kg/ha)	Boron levels (kg/ha) 0	2	4	0.2% spray at initiation of flowering and at 50% flowering	Mean	Source	S. Em±	C. D. (P=0.05)
0	46.28	49.36	51.32	52.75	49.86	Potassium	0.44	1.09
20	47.04	51.33	53.29	55.31	51.78	Boron	0.51	1.23
40	53.24	53.91	54.36	58.73	55.04	K x B	0.87	2.05
60	54.73	56.75	56.78	57.67	56.43	B x K	1.01	2.36
Mean	50.34	52.75	53.88	56.12				

to boron levels, all the treatment produced significantly higher biological yield over control, whereas, treatments with 2 kg B/ha and 4 kg B/ha remained statistically at par in results (Table 2).

Significant increase in seed yield (3.43 q/ha) was observed with 60 kg K_2O/ha over control. This could be attributed to role of potassium in the xylem and phloem transport system which helps in improving plant hormones and enzymes translocation efficient and strengthened the source-sink relationship (Coksun *et al*., 2017). Somewhat similar results were observed by Aboelgoud *et al.* (2015) in berseem and Chavan *et al*. (2012) in cowpea. Highest seed yield (3.63 q/ha) was recorded with treatment of 0.2% spray at initiation and at 50% flowering which was significantly higher than all other boron levels. These results are in a close agreement with the findings of Dhaliwal *et al*. (2008) in berseem.

Potassium significantly influenced the straw yield and highest straw yield was obtained at 60 kg K_2O/ha which was significantly higher over control. Foliar spray of boron @ 0.2% at initiation and at 50% flowering gave highest straw yield of 47.18 q/ha. Potassium levels hadn't marked any significant effect on the harvest index. But boron levels revealed significantly higher results with the 0.2% spray of boron at initiation and 50% flowering over control and 2 kg B/ha (Table 2).

CONCLUSION

As per the research findings, it may be concluded that for seed production, application of 60 kg K_2O/ha and 0.2% spray of boron at initiation and at 50% flowering alone in berseem gave maximum seed yield. If applying potassium and boron in combination then application of 40 kg K_2O/ha and 0.2% spray of boron at initiation and at 50% flowering gave maximum seed yield.

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