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Research Paper

Nutrient management of spring-summer blackgram (*Vigna mungo*) with cobalt, potassium and boron under different dates of sowing in Eastern India

PURABI BANERJEE[1], V. VISHA KUMARI[2] AND RAJIB NATH[3]

Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal 741 252

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ABSTRACT

A field experiment was conducted at the Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, during spring-summer seasons of 2020 and 2021, to study the effect of Co, K, B and date of sowing on blackgram [*Vigna mungo* (L.) Hepper]. The experiment was laid out in a split-split plot design, comprising 2 sowing dates in March with 15 days interval in main plot, 2 levels of soil application of Co at 4 kg/ha in subplots and 5 levels of foliar spray of 1.25% K and 0.2% B in sub-subplots. Pooled analysis of 2 years indicated that, the crop sown in March first week showed significantly higher (P>0.05) dry-matter (236.5 g/m^2), pods/plant (33.8), seed yield (1.3 t/ha) and protein content (23.2%) with a longer crop duration over the crop sown in March third week. Soil Co application and foliar K + B spray separately recorded higher seed yield (1.3 and 1.5 t/ha) and protein content (23.4 and 25.6%) respectively. Sowing of blackgram in the March first week with soil Co and foliar K + B application could improve its production potential in Gangetic plains of Eastern India.

Key words: Blackgram, Date of sowing, Nutrients, Spring summer, Yield

Blackgram [*Vigna mungo* (L.) Hepper] is a widely grown pulse crop, assuming considerable importance for food and nutritional security in India (Banerjee and Nath, 2021). It is an important short-duration pulse crop, typically grown in rainy (*kharif*) season in the country. Endowed with a unique capability of symbiotic nitrogen fixation, the crop has an excellent capacity to maintain soil fertility (Saleem *et al*., 2016). Blackgram seeds are exceptional source of protein, carbohydrate, fat, fibre, vitamin, and minerals (Jadhav *et al*., 2019). However, it has been observed that blackgram crop sown during spring-summer season faces moisture and heat stress throughout its growth period due to erratic and inadequate rainfall and rising atmospheric temperature. Sowing of blackgram during this season in optimum time necessitates prime focus for achieving optimum yield potential through proper harmony between the vegetative and reproductive stages of the crop (Singh *et al*., 2013). Besides, soil application or foliar spray of few nutrients like Co, K and B mitigates the adverse effect of various abiotic stresses.

A number of research works have explored the diverse and crucial roles of cobalt (Co), potassium (K) and boron (B) in boosting the overall growth and production of pulse crops under normal as well as under stress conditions (Patra and Bhattacharya, 2009; Math *et al*., 2014). Cobalt is a major component of co-enzyme cobalamine which stimulates different enzyme systems (Banerjee and Bhattacharya, 2021). Thus, it is considered to be responsible for the synthesis of leghaemoglobin protein necessary for root nodulation and biological nitrogen fixation (Awomi *et al*., 2012). Cobalt also increases amino acid content (Srivastava and Shukla, 2016). Potassium is associated with the maintenance of turgour pressure and osmoregulation in plants, thereby ameliorating water imbalances. Besides, it acts as a catalyst in activation of various enzymes and synthesis of peptide bonds (Sahay *et al*., 2013). Boron is accounted for cell-wall structure and carbohydrate transport while regulating nucleic acid and protein metabolisms (Banerjee *et al*., 2021a). Boron is also essential for photosynthetic activity, pollen germination and seed development of pulse crops (Bele and Thakur, 2019). The unique combination of beneficial (Co), macro (K) and micro (B) nutrients under study would be definitely a new potent area for the farmers as well as for the research domain of nutrient-management studies to

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[1]**Corresponding author's Email:** itsmepurabi1@gmail.com

[1]Ph.D. Research Scholar, [3]Professor, Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal 741 252; [2]Scientist, Division of Crop Sciences, ICAR-Central Research Institute for Dryland Agriculture, Hyderabad, Telangana 500 059

intensify the development and quality production of blackgram during spring-summer. Hence an experiment was planned with an objective to find out the effects of date of sowing and Co, K and B on growth, phenology, yield and quality of blackgram during spring-summer season.

MATERIALS AND METHODS

The field experiment was conducted, using blackgram as test crop, during spring- summer (March–June) seasons of 2020 and 2021 at District Seed Farm, Mohanpur, Nadia (22°93' N, 88°53' E and 9.75 m above mean-sea level) on a flat topography under Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India. The soil was well-drained, clay loam alluvial soil (order Inceptisols) with more or less neutral reaction (*p*H 7.2). The average temperature was 22.4–33.6ºC and 22.6–32.8ºC, with 6.1 and 0.1 cm rainfall during 2020 and 2021 respectively. The estimated values of experimental soil for available organic carbon (wet-digestion method), nitrogen (alkaline permanganate-oxidizable), P_2O_5 (Bray's P), and K_2O (NH_4OAc-extractable), Co (EDTA-extractable) and boron (Azomethine H) were 0.52 %, 264 kg/ha, 39 kg/ha, 197 kg/ha, 0.31 ppm and 0.46 ppm respectively. In the experimental soil, availability of both Co and B were in the deficient range (< 8 and < 0.5 ppm respectively) as per US EPA recommended levels.

The field experiment was laid out in a split-split plot design using the blackgram variety 'Pant Urd 31' in individual plots of size 4 m × 3 m, with a seed rate of 25 kg/ha at a row spacing of 30 cm × 10 cm during spring-summer season. The experiment comprised of 2 sowing dates in main plot (March first week and March third week), 2 soil application levels of Cobalt in subplots (no cobalt and Co at 4 kg/ha) and 5 foliar spray levels of K and B at flower initiation stage in sub-subplots (no spray, tap water, 1.25% K, 0.2% B and 1.25% K + 0.2% B) replicated thrice. General recommended dose of fertilizers (RDF @ 20 : 40 : 40 kg/ha N : P_2O_5 : K_2O) was applied basal at the time of blackgram sowing. One hand-weeding was done at 30 days after sowing (DAS). As the crop experienced a shortage of rainfall during this season, 1 pre-sowing irrigation was applied followed by occasional irrigations at an interval of 7–10 days up to 20 DAS for the establishment of proper crop stand. All the treatment means were separated through Fishers LSD (at 5% significance level) with the indication of significant differences ($P < 0.05$) by F test (Payne, 2009).

RESULTS AND DISCUSSION

Growth attributes

Sowing dates as well as foliar sprays showed significant differences in growth attributes of spring-summer sown blackgram according to the pooled estimation over 2 years (Table 1). Significant higher values for plant height, total dry matter, leaf-area index (LAI) and number of root nodules/plant were found when crop was sown in the March first week (56.1 cm, 236.6 g/m^2, 3.15 and 41.4 respectively). Kumar and Kumawat (2014) and Banerjee *et al*., (2021b) also reported similar increments in growth attributes with early sowing over delayed sowing in greengram and blackgram.

Besides, soil application of Co as well as combined

Table 1. Effect of sowing date, soil application and foliar nutrition on growth and phenology of blackgram

Treatment	Plant height (cm)	Total dry matter (g/m^2)	Leaf-area index	Effective nodules/ plant	Days to emergence	Days to flower initiation	Days to pod initiation	Days to maturity
Date of sowing								
March 1st week	56.1	236.6	3.15	41.4	6.3	34.2	41.1	81.9
March 3rd week	53.3	216.9	3.04	37.9	6.7	32.0	40.2	78.5
SEm±	0.11	0.39	0.01	0.08	0.05	0.06	0.05	0.05
CD (P=0.05)	0.54	2.51	0.03	0.51	0.29	0.38	0.29	0.29
Soil application of Co								
No cobalt	53.3	223.2	3.01	37.7	7.5	32.3	41.0	78.4
Co @ 4 kg/ha	55.9	230.3	3.19	41.6	6.1	34.2	43.3	82.0
SEm±	0.33	0.64	0.01	0.12	0.05	0.11	0.05	0.07
CD (P=0.05)	1.27	2.59	0.03	0.49	0.18	0.44	0.18	0.26
Foliar spray of nutrients								
No spray	47.9	207.8	2.93	36.2	7.0	32.3	40.4	77.2
Tap-water spray	51.3	218.1	3.01	37.4	6.9	32.9	41.4	78.7
1.25% K spray	54.7	227.5	3.11	39.6	6.9	33.2	42.2	80.4
0.2% B spray	58.1	234.8	3.18	41.4	6.6	33.7	43.0	81.5
1.25% K + 0.2% B spray	61.2	245.4	3.26	43.6	6.9	34.1	43.7	83.0
SEm±	0.31	0.88	0.02	0.24	0.18	0.14	0.11	0.13
CD (P=0.05)	0.92	2.54	0.07	0.70	NS	0.40	0.33	0.39

foliar spray of K + B recorded taller plants (55.9 and 62.2 cm) with greater dry-matter accumulation (230.3 and 245.4 g/m), LAI (3.19 and 3.26) and nodule count (41.6 and 43.6) respectively. Initial Co application was found to be accounted for height elongation as well as leaf-area expansion along with restricted leaf senescence while facilitating nodulation and symbiotic nitrogen fixation (Minz *et al*., 2018). Besides, foliar spray of K + B just at the beginning of flowering stage of blackgram might have also helped in profuse branching, leaf production and acceleration of nodule formation irrespective of dates of sowing (Kumar *et al*., 2020).

Phenology

As a whole, the overall crop duration was declined with delay in sowing, starting from March first week to third week (Table 2). Rapid emergence of blackgram seedlings was observed under March first week sowing (6.3 days) as well as with the application of Co (6.1 days) in soil. On an average, blackgram sown in the first week of March finished its life-cycle in 81.9 days, which was only 78.5 days in case of the later crop. Similar observations of early maturation in summer-sown blackgram due to delayed sowing were reported by Mane *et al.,* (2017) and Banerjee *et al*., (2021a). The crop sown in the first week March took more days from pod initiation to maturity, implying availability of more time for the seed filling and consequently better yield. However, provision of Co in soil as well as K and B as foliar visibly extended the requirement of days for formation of pods from flowers (43.3 and 43.7 days respectively) with significant variations. Increments in the numbers of days to attain maturity with soil application of Co (82.0 days) and foliar spray of K+B (83.0 days) might be attributed to the ability of Co and foliar nutrition in accelerating the production of flowers, aiding in extending the maturity (Kumari *et al*., 2020; Banerjee *et al*., 2021b).

Yield characters and seed protein content

Sowing of blackgram in the first week of March resulted in significant improvements in yield-attributing characters, viz. in terms of number of pods/plant (33.8), pod length (5.4 cm) and test weight (37.3 g) over the crop sown in the third week of March (30.9, 4.9 cm and 36.2 g respectively), which ultimately led to significantly higher seed yield (1.3 t/ha), stover yield (2.6 t/ha), harvest index (44.5%), with enrichment of protein content (23.2%) in seeds in the first crop (Table 2). The March first week-sown crop had more time available for both the processes of flower to pod conversion and subsequent seed-filling, and thus achieved superior quality and quantity of yield than the later sown one with reduced reproductive span (Rehman *et al*., 2009). The delayed sown crop might have left with lesser soil moisture at the time of seed-filling, which probably resulted in poor source to sink partitioning, hampered seed-filling and eventually reduction in yield potential and seed quality.

Soil application of cobalt resulted in greater number of pods (34.0) with higher length (5.3) containing seeds filled with more amount of protein (23.4%). Among the various foliar-applied plots, foliar K in combination with B resulted in the highest number of pods/plant (41.2) and longer individual pods (6.4) with greater seed protein content (25.6%). Nevertheless, nutrients application exerted no such impact on the test weight of spring summer-sown blackgram. Accordingly, soil application of Co and foliar K + B spray separately resulted in significant increase in

Table 2. Effect of sowing date, soil application and foliar nutrition influencing yield characters and seed protein content of blackgram

Treatment	Number of pods per plant	Pod length (cm)	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Seed protein content (%)
Date of sowing							
March 1st week	33.8	5.4	37.3	1.3	2.6	44.5	23.2
March 3rd week	30.9	4.9	36.2	1.1	2.4	44.0	22.4
SEm±	0.29	0.04	0.06	6.15	1.53	0.08	0.07
CD (P=0.05)	1.71	0.23	0.40	17.94	9.47	NS	0.42
Soil application of Co							
No cobalt	27.7	5.1	36.0	1.2	2.4	43.2	22.1
Co @ 4 kg/ha	34.0	5.3	37.5	1.3	2.5	45.5	23.4
SEm±	0.33	0.02	0.07	4.25	6.34	0.12	0.08
CD (P=0.05)	1.30	0.07	NS	16.59	24.76	0.46	0.31
Foliar spray of nutrients							
No spray	19.7	4.1	34.5	0.8	2.1	42.9	20.2
Tap water spray	25.4	4.5	35.7	1.1	2.3	43.7	21.4
1.25% K spray	31.1	5.2	36.8	1.2	2.5	44.4	22.7
0.2% B spray	36.4	5.8	37.9	1.3	2.6	44.9	23.9
1.25% K + 0.2% B spray	41.2	6.4	38.8	1.5	2.8	45.6	25.6
SEm±	0.41	0.04	0.16	9.07	8.65	0.19	0.10
CD (P=0.05)	1.18	0.12	NS	26.13	24.93	0.55	0.29

seed yield (1.3 and 1.5 t/ha), stover yield (2.5 and 2.8 t/ha) and harvest index (45.5 and 45.6%) over their respective controls. Cobalt might be involved in the synthesis of leghaemoglobin protein required for rhizobial activity in legumes and subsequent nitrogen fixation (Awomi *et al.*, 2012; Minz *et al.*, 2018). In fact, the application of Co invariably accounted for greater nodulation and protein synthesis (Marimuthu and Surendran, 2015). The combined spray of K at 1.25% and B at 0.2% seemed to potentially encourage considerable symbiotic nitrogen fixation, flowering, and seed development (Banerjee *et al.*, 2021b), which was clearly justified by the higher seed yield and protein content in both 2020 and 2021.

Based on the above findings, it may be concluded that sowing in the first week of March along with basal soil application of Co at 4 kg/ha and exogenous foliar nutrition of 1.25% K and 0.2% B at flower-initiation stage are potent agronomic managements for the farmers of Eastern India to intensify blackgram production. Even in case of delayed sowing, application Co in soil coupled with K + B foliar spray can successfully manage to sustain optimum growth and production potential of blackgram through alleviation of heat and moisture stresses predominant during spring-summer.

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