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Yield & yield components in chickpea (*Cicer arientinum* L.) as influenced by seed priming & foliar spray of bio-agents

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Abstract
An field experiment entitled "effect of seed priming and foliar spray of bio-agents on yield and yield components in chickpea (*Cicer arietinum* L.)" was conducted during *rabi* 2017 at experimental field of STRU (Seed Technology Research Unit), Khanapur block-B, VNMKV, Parbhani, M.S. The experiment was laid out in randomized block design with three replications and ten treatments. Seed of chickpea var. Akash (BDNG-797) was subjected to seed priming with different bioagents for 12 hrs. Before sowing. The different bio-agents were applied as foliar application at different stages (at 15 days interval). The treatment Biomix @ 10ml/lit was found significantly superior for maximum speed of germination at field level. The plant height and number of branches increased significantly with spraying of bio-agent @ 10ml/ha. The bio-agents treatments significantly decrease days to flowering (38.7 days), days to 50% flowering (47.7 days) and days to physiological maturity (92.0 days) as compared to control. Yield parameters *viz.*, Number of pods per plant (81.8 plant^{-1}), number of seeds per plant (89.7),100 seed weight (22.8g), seed yield per plot (2.34 kg), seed yield per hector (2600 kg/ha) and harvest index (59.5%) increased significantly due to application of biomix @10ml/lit. followed by the treatment *Metarhiziumanisopliae*@10ml/lit. in the chickpea genotype Akash (BDNG-797).

Keywords: Chickpea, seed priming, bio-agents, biomix, metarhizium anisopliae, yield

Introduction
Among the pulses, the major contribution to the total pulse production comes from chickpea. Gram is important pulse crop occupying third position among the gram legume in world, considered as king of pulses. Chickpea (*Cicer arietinum* L.) is an important *rabi* season self-pollinated legume crop having extensive geographical, distribution. Chickpea is also known as gram, chana, Bengal gram or spinach pea etc. Chickpea is a diploid species with a chromosome number 2n=16. It belongs to sub-family papilionaceae of the family *Leguminosae*. India is the largest producer of pulses in the world with 25% share in global production. It is said to be one of the oldest pulse known to be cultivated from ancient time both in Asia and Europe. The major production of chickpea comes from central and northern India (Vishwas *et al*., 2017) [7]. Pulse crop have a specific importance for the vegetarian population of our country. However due to explosion and low productivity of pulse crop. Per capita availability of pulse is consistently decreasing. Per capita availability of pulse per day is only 47 gm. as against the minimum requirement of 104 gm. as requirement by the nutritional experts of World Health Organization. Statistically, it occupies about 105.73 Lakh hactor area with production of 111.58 lakh tonnes. The yield productivity is about 1056 kg/ha in 2017-18 in India. (Source-DES Ministry of Agriculture & FW (DAC & FW) GOI IVth *Adv. Est.* 2017-2018).
Strategies of improving the growth and development of crop species have been investigated for many years. Rapid germination and emergence are essential for successful crop establishment for which seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield. It is simple and low cost hydration technique in which seed are partially hydrated to a point were pre-germination metabolic activities start without actual germination and then re-dried until close to the original dry weight exhibit faster rate of germination, more uniform emergence, greater tolerance to environmental stress (Singh *et al*., 2015) [6]. In view of the above circumstances, the present investigation was undertaken to study the effect of seed priming and foliar spray of bio-agent on yield and yield components.

Material and Methods

A field experiment entitled "Effect of seed priming and foliar spray of bio-agents on yield and yield components in chickpea (*Cicer arietinum* L.)" was conducted during *rabi* 2017 at experimental field of STRU (Seed Technology Research Unit), Khanapur block-B, VNMKV, Parbhani. The experiment was laid out in randomized block design with three replications and ten treatments. The different bio-agents i.e. T_1- Biomix, T_2-*Trichondermaviride* @10ml/lit., T_3-*Azospirillum brasilense* @10ml/lit., T_4-*Glucanoacetobacter spp* @10ml/lit., T_5-*Pseudomonas fluorescence* @10ml/lit., T_6-*Pseudomonas striata* @10ml/lit., T_7-*Metarhiziumanisopliae* @10ml/lit., T_8-*Beauveria bassiana* @10ml/lit., T_9-*Aspergillus niger* @10ml/lit and T_{10}-control were applied as foliar application at different stages (at 15 days interval). Seed of chickpea var. Akash (BDNG-797) was subjected to seed priming with different bioagents for 12 hrs. Before sowing. The observations on speed of germination, days to 50% flowering, days to maturity and seed yield were recorded on plant height, number of branches per plant, plant population, number of pods per plant, number of seeds per plant, 100 seed weight, seed yield (kg/plot), seed yield (kg/ha), biological yield (kg/plot) an d harvest index (%).

Result and Discussion

1. Speed of Germination

The data regarding the total speed of germination after sowing indicated that the treatment T_1-Biomix @ 10ml/lit. (72.0%) followed by T_7-*Metarhiziumanisophilae* @ 10ml/lit. (69.4%) was recorded significantly highest speed of germination and both are at par with T_3-*Azospirillum brasilense* @10ml/lit. (64.92%), T_4-*Glucanoacetobacter* spp. @10ml/lit. (65.9%) and T_2-*Trichonderma viride* @ 10ml/lit. (65.5%) as compared to other treatments and control (50.87%). Speed of germination it may because of the accelerated germination of primed seeds might be due to increased rate of cell division.

2. Plant Height (cm)

The data indicated that the plant height was not influenced significantly by different treatment of bio-agents. Whereas the treatment T_1-Biomix @ 10ml/lit. (58.7cm), T_7-*Metarhizium anisophilae* @ 10ml/lit. (58.1 cm) and T_4-*Glucanoacetobacter* spp. @ 10ml/lit. (58.3cm) was recorded numerically higher plant height at harvest as compared to other treatments and control (57.1 cm). This could be an account of vigorous vegetative growth due to greater cell division and more meristematic active increasing supply of photosphates for the formation branches.

3. Number of Branches Per Plant

The result indicated that the treatment T_7-*Metarhizium anisophilae* @ 10ml/lit. (9.7) followed by T_1-Biomix @ 10ml/lit. (9.3) and T_9-*Aspergillus niger* @ 10ml/lit. (9.3) were recorded highest number of branches than treatments and T_{10}-control (8.9).

4. Days to 50% Flowering

The days to 50% flowering was influenced significantly by different treatment of bio-agents. All the treatments were recorded significantly lowest days to 50% flowering over control (54 days) except treatment T_8-*Beauveria bassiana*@ 10ml/lit. (56.7 days) and T_9-*Aspergillusniger* @ 10ml/lit. (53.0 days) which was at par with control. The delay in flowering is may be due to non-availability of plant growth promoting substances, less nutrient mobilization and low nutrient uptake (Singh *et al*., 2013 in chickpea) [5].

5. Days to Maturity

The treatment T_7-*Metarhizium anisophilae* @ 10ml/lit. (92.0 days), T_1-Biomix @ 10ml/lit.(92.2days), T_3-*Azospirillum brasilense* @ 10ml/lit. (92.3 days) and T_4-*Glucanoacetobacter* spp. @ 10ml/lit. (92.6 days) shows significantly minimum days to maturity over T_{10}-control @ 10ml/lit (103.3 days) and T_9-*Aspergillus niger* @ 10ml/lit (99 days). Earliness might be due to the enhanced production of growth substances like gibberllic acid, indole acetic acid, dihydrozeatin from bioagent which had positive influence on physiological activity of plants which could assist the plants to induce early flowering and maturity. This findings are conformity with (Jitender *et al*., (2018) in mungbean.

6. Plant Population

The treatment T_1-Biomix @ 10ml/lit. (234.6) followed by T_7-*Metarhizium anisophilae* @ 10ml/lit. (205.6) was recorded significantly highest plant population and it was at par with T_4- *Glucanoacetobacter* spp. @ 10ml/lit. (199.3), T_3-*Azospirillum brasilense* @ 10ml/lit. (192.6) and T_2-*Trichonderma viride* @ 10ml/lit. (184.3). However lowest plant population was recorded by treatment T_6-*Pseudomonas striata* @ 10ml/lit.(160.3), T_8-*Beauveria bassiana*@ 10ml/lit.(168.0), T_9-*Aspergillus niger* @ 10ml/lit. (166.33), T_{10}-control (151.3).

7. Number of Pods Per Plant

The result revealed that the treatment T_1-Biomix @ 10ml/lit. (81.8) was significantly highest number of pods per plant and it was found at par with T_7-*Metarhizium anisophilae* @ 10ml/lit. (77.9). However lowest number of pods per plant was recorded in T_9-*Aspergillusniger* @ 10ml/lit. (54.7) and T_{10}-control (52.07).

8. Number of Seeds Per Plant

The result indicated that the treatment T_1-Biomix @ 10ml/lit. (89.7) followed by T_7-*Metarhiziumanisophilae* @ 10ml/lit. (88.8) was recorded significantly higher number of seeds per plant and it was found at par with T_4-*Glucanoacetobacter* spp. @ 10ml/lit. (86.2) and T_3-*Azospirillum brasilense* @ 10ml/lit. (82.4) over treatment T_{10}-control (69).

9. 100 Seed Weight (g)

The treatment T_1-Biomix @ 10ml/lit. (22.8 g.) followed by T_7-*Metarhizium anisophilae* @ 10ml/lit. (22.1g.) was recorded significantly higher 100 seed weight and at par with T_4-*Glucanoacetobacter* spp. @ 10ml/lit. (22.0g.), T_3-*Azospirillum brasilense* @ 10ml/lit. (21.5g.) and T_2-*Trichonderma viride* @10ml/lit. (20.6g.) as compared to other treatments and T_{10}-control (17.0g.). This increase in 100 seed weight may be due to the more availability of nutrient like nitrogen and phosphorus in the rhizosphere.

10. Seed Yield (kg/plot)

The treatment T_1-Biomix @ 10ml/lit. (2.34 kg/plot) followed by T_7-*Metarhizium anisophilae* @ 10ml/lit. (2.32 kg/plot) was recorded significantly higher seed yield and both are at par with T_4-*Glucanoacetobacter* spp. @ 10ml/lit. (2.26 kg/plot) and T_5-*Pseudomonas fluorescence* @10ml/lit. (2.27 kg/plot) as compared to other treatments and T_{10}-control (1.95 kg/plot). Bacteria had beneficial effect on plant growth and

seed yield, because they fix atmospheric nitrogen and release auxins to the root zone to enhance growth.

11. Seed yield (kg/ ha)

The treatment T_1-Biomix @ 10ml/lit. (2600 kg/ha) followed by T_7-*Metarhizium anisophilae* @ 10ml/lit (2578 kg/ha) was recorded significantly higher seed yield and both are found at par with treatment T_5-*Pseudomonas fluorescence* @ 10ml/lit. (2522kg/ha) and T_4-*Glucanoacetobacter* spp. @ 10ml/lit. (2511 kg/ha) as compared to T_{10}-Control (2167 kg/ha).

12. Biological Yield (kg/plot)

The treatment T_1-Biomix @ 10ml/lit. (3.93 kg/plot) followed by T_7-*Metarhizium anisophilae* @ 10ml/lit. (4.03 kg/plot) was significantly lower biological yield as compared to other treatments. However, highest biological yield recorded by the treatment T_{10}-control (5.3 kg/plot). Biological yield is attributed because of increased height, leaf area and dry matter production.

13. Harvest Index (%)

The treatment T_1-Biomix @10ml/lit. (59.5%) and T_7-*Metarhizium anisophilae* @ 10ml/lit. (57.6%) was recorded significantly higher harvest index and at par with T_4-*Glucanoacetobacter* spp. @ 10ml/lit. (52.1%) as compared to T_{10}-Control (36.7%).

These result were in accordance with the findings of Goutam *et al*., (2004) in chickpea, Yamak *et al*., (2017) [8] in pearl millet, Patra *et al*., (2018) [4] in wheat and Jitender *et al*., (2018) in mungbean who reported that biomix significantly increased harvest index.

Conclusion

The treatment Biomix @ 10ml/lit was found significantly superior for maximum speed of germination at field level. The plant height and number of branches increased significantly with spraying of bio-agent @ 10ml/ha. The bio-agents treatments significantly decrease days to flowering (38.7 days), days to 50% flowering (47.7 days) and days to physiological maturity (92.0 days) as compared to control. Yield parameters *viz.*, Number of pods per plant (81.8 plant^{-1}), number of seeds per plant (89.7), 100 seed weight (22.8g), seed yield per plot (2.34 kg), seed yield per hector (2600 kg/ha) and harvest index (59.5%) increased significantly due to application of biomix @10ml/lit. followed by the treatment *Metarhiziumanisopliae*@10ml/lit. in the chickpea genotype Akash (BDNG-797).

Table 1: Effect of seed priming and foliar spray of bio-agents on morphological parameters

Treatments	Speed of germination	Plant height (cm)	Number of branches per plant	Days to 50% flowering	Days to maturity	Plant population
T_1-Biomix @ 10ml/lit.	72.0	58.7	9.3	48.7	92.2	234.6
T_2-*Trichonderma viride* @ 10ml/lit.	65.5	57.6	8.5	49.0	95.0	184.3
T_3-*Azospirillum brasilense* @ 10ml/lit.	64.9	55.5	8.0	49.7	92.3	1sss92.6
T_4-*Glucanoacetobacter* spp.@ 10ml/lit.	65.9	58.3	8.8	50.3	92.6	199.3
T_5-*Pseudomonas fluroscence* @ 10ml/lit.	57.8	49.8	9.0	49.0	95.6	175.5
T_6-*Pseudomonas striata* @ 10ml/lit.	56.0	51.2	8.0	47.7	94.3	160.3
T_7-*Metarhizium anisophilae* @ 10ml/lit.	69.4	58.1	9.7	48.3	92.0	205.6
T_8-*Beauveriabassiana* @ 10ml/lit.	54.0	48.7	9.0	56.7	95.0	168.0
T_9-*Aspergillusniger* @ 10ml/lit.	52.9	56.7	9.3	53.0	99.0	166.3
T_{10}-Control	50.8	57.1	8.9	54.0	103.3	151.3
Mean	60.8	55.3	8.8	50.6	95.13	183.8
SE±	2.79	3.39	0.07	1.33	3.65	19.81
CD @ 5%	8.30	NS	0.20	3.84	10.87	58.86
CV%	8.01	10.1	14.1	5.6	6.73	18.66`

Table 2: Effect of seed priming and foliar spray of bio-agents on yield and yield components

Treatments	Number of pods per plant	Number of seeds per plant	100 seed weight (g)	Seed yield (kg/plot)	Seed yield (kg/ha)	Biological yield (kg/plot)	Harvest index (%)
T_1-Biomix @ 10ml/lit.	81.8	89.7	22.8	2.34	2600	3.93	59.5
T_2-*Trichonderma viride* @ 10ml/lit.	62.0	75.8	20.6	2.22	2467	4.68	47.4
T_3-*Azospirillum brasilense* @ 10ml/lit.	63.7	82.4	21.5	2.20	2444	4.46	49.3
T_4-*Glucanoacetobacter* spp.@ 10ml/lit.	73.8	86.2	22.0	2.26	2511	4.34	52.1
T_5-*Pseudomonas fluroscence* @ 10ml/lit.	71.7	77.7	18.0	2.27	2522	4.61	47.9
T_6-*Pseudomonas striata* @ 10ml/lit.	57.6	76.7	19.4	2.21	2455	4.78	48.5
T_7-*Metarhizium anisophilae* @ 10ml/lit.	77.9	88.8	22.1	2.32	2578	4.03	57.6
T_8-*Beauveria bassiana* @ 10ml/lit.	60.9	70.9	17.7	2.12	2356	4.49	47.2
T_9-*Aspergillus niger* @ 10ml/lit.	54.7	71.6	18.4	2.15	2389	4.75	45.3
T_{10}-Control	52.0	69.0	17.0	1.95	2167	5.31	36.7
Mean	63.8	76.58	19.96	2.20	2449	4.55	49.0
SE±	4.73	4.49	1.59	0.10	123	0.41	1.79
CD @ 5%	14.60	13.35	4.75	0.30	367.4	1.18	5.33
CV%	12.84	10.16	13.92	9.60	8.74	19.7	6.33

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