

Foliar applied brassica water extract improves the seedling development of wheat and chickpea

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Abstract

An experiment was conducted to check the brassica water extract as natural growth regulator in improving the seedling development of wheat and chickpea. Experimental treatments included five low concentration levels of brassica water extract as 1%, 1.5%, 2%, 2.5% and 3% as foliar spray. Two other treatments where no spray and water was used as foliar spray, were considered as control treatments. To compare the efficacy of natural growth regulator, a synthetic source was also maintained among foliar sprays in the form of 6-Benzylaminopurine. In conclusion, results of the experiment concluded that 2% brassica water extract was most effect level to maximally boost the seedling characteristics like shoot/root biomass, shoot/root length and number of leaves till 20 days after germination. However, this level varied in case of chickpea where a bit higher concentration, 3% yielded maximum outcomes to the recorded parameters. So, findings of the study suggest that growth promotion potential of crops like brassica should be exploited in sustainable agriculture systems.

Keywords: Crop extract, Growth regulators, Seedling enhancement, Foliar spray

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Introduction

All species belong to brassicaceae family are assumed to have allelopathic potential (Rehman et al., 2013). Cultivated as well as wild species of brassica are allelopathic in nature and natural weed suppressor, likewise; Siemens et al. (2002) suggested that mustard in wild is successful intruders of native grassland.

Allelopathy, as a phenomenon of biochemical interaction among living organisms has both direct as well as indirect influence. These biochemicals or allelochemicals can be released from plant residues or as leachates from roots, stems, fruits, leaves and seeds also to show allelopathic activity (Ashrafi et al., 2008; Asgharipour and Armin, 2010). Further, these allelochemicals have both inhibitory and promotive



effects on the receiving plants, accordingly can act as natural growth promoters or natural pesticides (Chon and Kim, 2002).

Several species of Brassicaceae family were reported to have allelopathic potential by influencing the germination as well as seedling emergence of different plants (Haramoto and Gallandt, 2004). While, many putative allelochemicals have been isolated from Brassicaceae and their allelopathic potential was demonstrated in various bioassays. Furthermore, an important allelopathic compound namely glucosinolates which is present in all plant parts, however, its concentration is not uniform in all plant parts.

Allelopathy of brassica species can also be exploited in both ways of growth stimulation and inhibition. Brassinolide is naturally occurring plant hormone in brassica which shows growth promoting activity (Wada et al., 1981). To evaluate the allelopathic activity of brassica extract, germination bioassays are usually conducted to check the sensitivity of test species (Kordali et al., 2007). Keeping in view these information, a bioassay was planned to check the response of aqueous extract of brassica in various concentrations against the seedling growth of wheat and chickpea. The hypothesis of this bioassay was that brassica extract containing allelochemicals when applied in lower concentrations will enhance the growth of both test crops, representative of monocot and dicot.

Material and Methods

Brassica water extract in various lower concentrations was investigated in a glasshouse experiment. The site was located at 30.10° N, 71.25° E with altitude of 128 masl.

Experimental details

Small pots filled by 250 grams of pre-washed sand were used. These were arranged in completely randomized design (CRD) with eight treatments while, replicated three times. Seven seeds of wheat (*Triticum aestivum* L.) and chickpea (*Cicer arietinum* L.) were planted in every pot. At final emergence, these pots were retained to only 4 seedlings by thinning. Foliar application was done 10 days after sowing (DAS) as per treatments, T₀ = no spray, T₁ = simple water as foliar spray, T₂ = 1% brassica water extract (BWE), T₃ = 1.5% BWE, T₄ = 2% BWE, T₅ = 2.5% BWE, T₆ = 3% BWE and T₇ = 5ppm 6-Benzylaminopurine (BAP). Seedlings were

subsequently irrigated with distilled water when needed up to 20 days after germination.

Extract preparation

For the preparation of BWE; rapeseed (*Brassica napus* L.) was harvested at maturity and preserved to dry over duration of 2 weeks at some shady place. After complete drying, this plant material was chopped in to small pieces and one kg of this was soaked in ten liters of normal irrigation water for twenty four hours. After the required soaking time the filtrate was passed through thin muslin cloth to get pure extract free from all impurities. Now the volume of this material was reduced to twenty times by subsequently boiling at 100°C temperature. This final material was considered as pure 100% BWE and collected in pre-washed bottle and stored in refrigerator until applications.

Observations

All the seedlings were harvested after 20 days of foliar applications. Data was recorded for the following parameters; root-shoot length (cm), root-shoot biomass (g), and final leaf numbers. Root-shoot lengths were measured with a measuring scale. Whereas, after taking fresh weights with a digital balance seedling were placed in a hot air oven for 48 hours at 72° centigrade for complete drying and further weighed. Leaves were manually counted to get the number of leaves per plant.

All the recorded data was examined statistically by procedure devise by Steel et al. (1997).

Results

Wheat parameters

Root and shoot length

All the foliar application of BWE treatments significantly influenced the root and shoot length of wheat seedling (Fig. 1). Maximum root and shoot length of wheat was recorded at 2% foliar application of BWE in comparison to all other applications. While, statistically similar improvement of root and shoot length of wheat was recorded with foliar application of BAP at 5 ppm. Whereas, minimum root and shoot length of wheat was achieved in first two treatments where no spray and water was applied as foliar spray. Enhancing the level of BWE beyond 2% could not further improve the root and shoot length of wheat but in comparison to control applications all the concentrations of BWE improve the both parameters of wheat (Fig. 1).



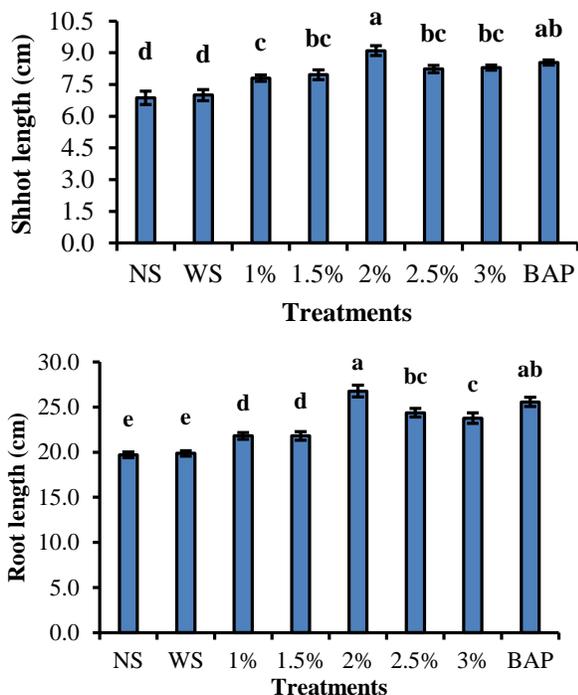


Figure-1. Shoot length (left) and root length (right) of wheat as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

Root and shoot biomass of wheat seedling

In biomass, root and shoot fresh weight and dry weight was recorded. Similar to root and shoot length, all the concentrations of BWE foliar sprays significantly improved the root and shoot biomass of wheat seedling (Fig. 2 & 3). Maximum shoot fresh and dry weight was recorded at 2% foliar application of BWE in comparison to all other treatments. While, statistically similar measurements of shoot fresh and dry weight were recorded with BAP application as foliar spray. However, minimum fresh and dry weights of shoot were recorded in both control treatments where no spray and water spray was applied (Fig. 2).

In case of root fresh and dry weights, maximum values were recorded again at 2% concentration of BWE as foliar spray. Statistically similar measurement of root fresh weight was recorded with BAP application but in case of root dry weight, BAP application did not give similar results but followed the 2% BWE application (Fig. 3). However, enhancing the level of BWE beyond 2% could not further improve the root and shoot biomass but in comparison to control applications all the concentrations of BWE improve the biomass of root and shoot (Fig. 2 & 3).

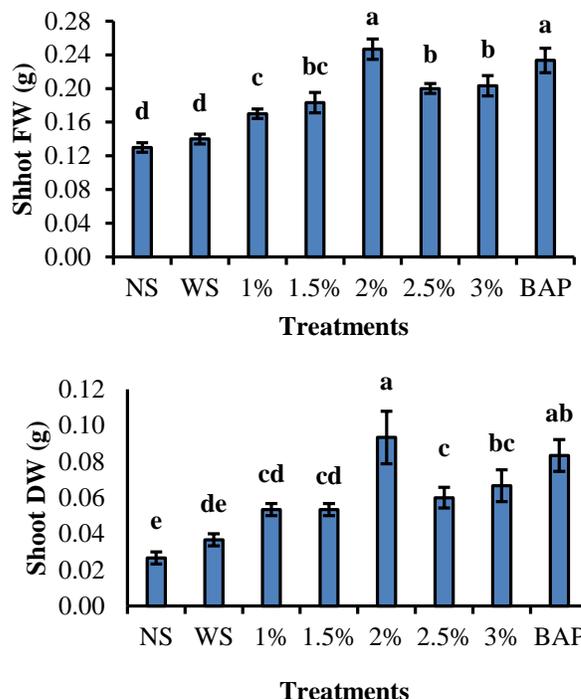


Figure-2. Shoot fresh weight (left) and shoot dry weight (right) of wheat as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

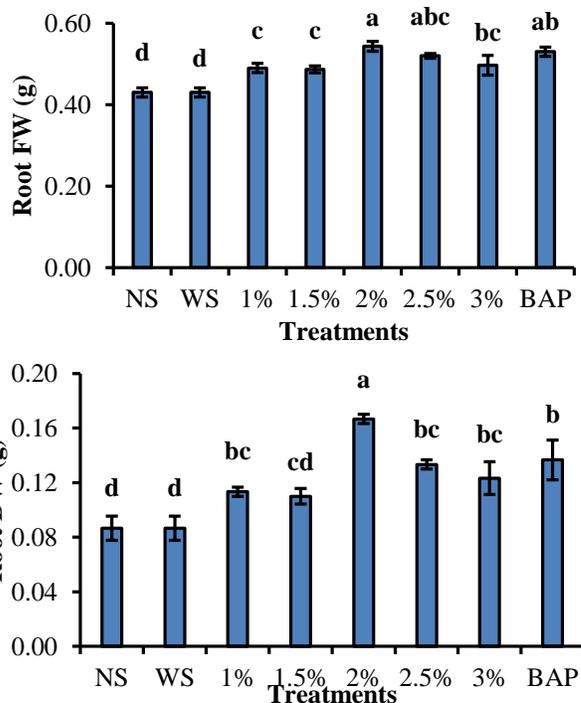


Figure-3. Root fresh weight (left) and root dry weight (right) of wheat as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

No. of leaves of wheat and chickpea seedlings

Data regarding number of leaves of wheat as influenced by different foliar applications showed statistically significant results (Fig. 4). In case of wheat, maximum number of leaves were counted, where BWE was applied as foliar spray at 2% concentration and statistically similar number was recorded in case of BAP application. While, increasing the concentration of BWE beyond 2% could not enhance the number of leaves rather decreased the count. However, in comparison to no application treatment, all other application enhance the leaves of wheat (Fig. 4).

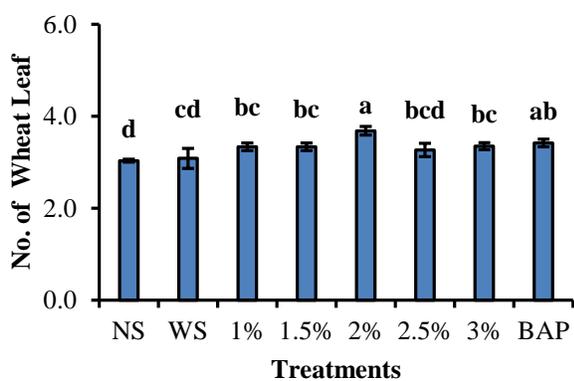


Figure-4. No. of leaves of wheat as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

Chickpea parameters

Root and shoot length

Foliar application of all the treatments revealed a significant influence on the root and shoot length of chickpea seedling (Fig. 5). In comparison to all treatments, highest root and shoot length of chickpea was recorded when BWE at 3% was applied as foliar spray. In shoot length, this was followed by foliar application of lower concentrations of BWE at 1%, 1.5%, 2% and BAP while, in case of root length this was followed by lower concentrations foliar applications of BWE at 1.5%, 2% and 2.5% (Fig. 5). Whereas, minimum root and shoot length of chickpea was noted in treatments where no spray and water as foliar spray was applied. For root growth of chickpea BAP could not give very good results (Fig. 5)

Root and shoot biomass of chickpea seedling

Like to root and shoot length, all the concentrations of BWE foliar sprays significantly improved the root and

shoot biomass of chickpea seedling (Fig. 6 & 7). Highest shoot fresh and dry weights were recorded at 3% foliar application of BWE in comparison to all other treatments. Regarding shoot fresh weight, BAP application at 5 ppm gave statistically similar results, while, other low concentration applications of BWE at 2% and 2.5% followed it. But for shoot dry weight, BAP and 2% of BWE foliar sprays followed the maximum dry weight (Fig. 6). Whereas, lowest fresh and dry weights of shoot were noted where no any spray was done (Fig. 6).

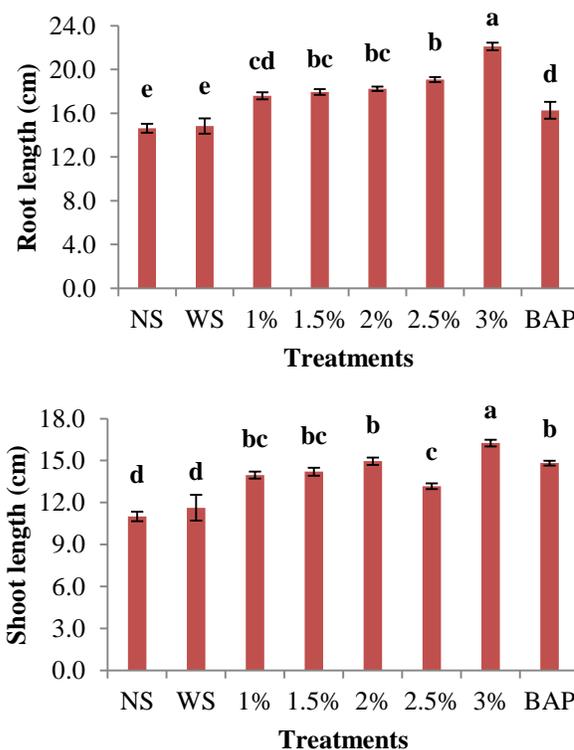


Figure-5. Shoot length (left) and root length (right) of chickpea as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

In case of root fresh and dry weights, highest values were obtained at 3% BWE applied as foliar spray. This was followed by BAP application along with lower dose applications of BWE at 1.5% and 2% (Fig. 7). Minimum values for fresh weight of roots of chickpea was recorded where no spray and water application as foliar spray was done, whereas, for dry weight minimum values were recorded where nothing was sprayed (Fig. 7).

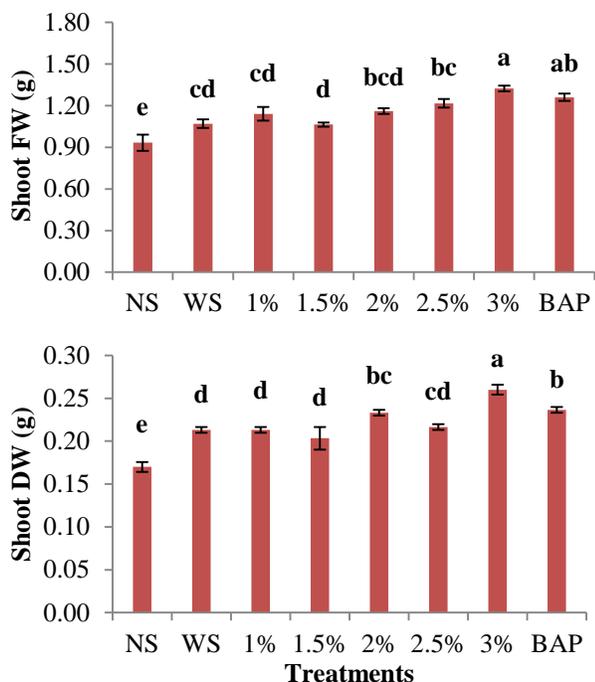


Figure-6. Shoot fresh weight (left) and shoot dry weight (right) of chickpea as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

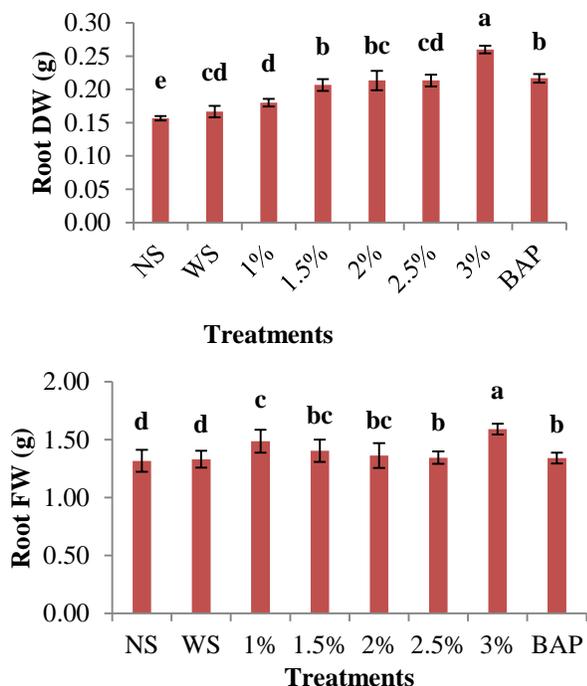


Figure-7. Root fresh weight (left) and root dry weight (right) of chickpea as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

No. of leaves of chickpea seedlings

Data regarding number of leaves of chickpea as influenced by different foliar applications showed statistically significant results (Fig. 8). Maximum leaves were achieved at foliar application of 3% BWE, following by the foliar BAP application and two lower concentration application at 2% and 2.5% of BWE. Whereas, other lower concentration applications (1% and 1.5% BWE) also improve this number in comparison to no spray treatment.

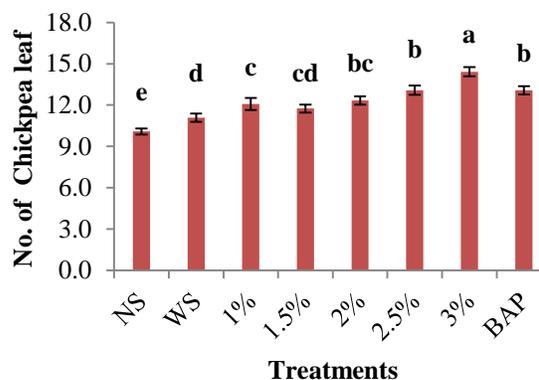


Figure-8. No. of leaves of wheat (left) and chickpea (right) as influenced by different concentrations of BWE. NS= No Spray, WS= Water Spray, BAP= 6-Benzylaminopurine

Discussion

Foliar applied brassica water extract at lower concentrations (1, 1.5, 2, 2.5 and 3%) were applied on the germinated seedlings of wheat and chickpea. Seedling growth of both these test species was investigated for 20 days after germination. Brassica extract was applied as a natural growth regulator and there are several field investigations that support this idea to check it as growth regulator as foliar spray (Jahangeer, 2011; Iqbal, 2011; Awan et al., 2012; Shahzad et al., 2017). However, a synthetic growth regulator in the form of BAP was also used in the studies to compare the efficacy of both natural and synthetic sources. BAP has also been tested in many field studies as a potential growth regulator (Yasmeen et al., 2013; Bajwa and Farooq, 2017; Bajwa et al., 2018). Brassica extract possess several potential secondary metabolites viz. brassinolide, isothiocyanates glucosinolates, thiocyanates (Grove et al., 1979; Romanowski and Klenk, 2000; Agerbirk and Olsen, 2012), these have a vital action in growth actions of plants; like chlorophyll accumulation,

photosynthesis, expansion of leaf and transpiration (Gamalero and Glick, 2011). In case of monocot specie wheat crop, BWE at only 2% concentration showed best result in all the recorded parameters like, shoot/root biomass, shoot/root length and number of leaves (Fig. 1-3). While, BAP also showed almost similar response as recorded in case of 2% BWE foliar spray, in most of the recorded parameters of the wheat, however, other concentrations of BWE also improve the aforementioned parameters in comparison to control treatments (Fig. 1-3). This optimized level of 2% BWE in seedling development study was contrary to the earlier investigated level, where researchers optimized 5% BWE concentration for field study of wheat crop (Shahzad et al., 2017). However, the results of controlled condition experiment haven't maintained 5% concentration. In case of chickpea, a dicot representative, same level of BWE (2%) could not give the best results, but here all the recorded parameters performed best when we applied 3% BWE as foliar spray (Fig. 4-6). Brassinolide, an important secondary metabolite present in brassica extract, have been tested as foliar applied growth regulator in various studies and consequently the yield and yield contributing traits of all the test crops including, maize, rice, black gram was enhanced (Yokota and Takahashi 1986; Mayumi and Shibaoka 1995; Jeyakumar et al. 2008). Moreover, these secondary metabolites are concentration dependent (Farooq et al. 2013); at higher concentration these inhibit the growth of test species while at lower concentrations these endorse the biological processes of plants and consequently growth and yield of the plants is enhanced. Similar is the case with brassica species, that possess such chemicals and their low concentration application promote the growth and among these few were named as brassins (Mitchell et al., 1970). So, from all this discussion, it is very much clear that these are secondary metabolites which are responsible for the action of seedling development for both the test crops.

Conclusion

It can be concluded that BWE is a natural growth regulator when used in lower concentrations. Foliar application of BWE led to enhance seedling parameter like shoot/root biomass, shoot/root length and number of leaves. It can be recommended that low concentration levels of BWE at 2% and 3% are

important for promoting the seedling development of wheat and chickpea respectively.

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Conflict of Interest: None.

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Contribution of Authors

- Farooq O: Conceived idea, data interpretation, manuscript final reading and approval
- Ali M: Designed research methodology and data interpretation
- Sarwar N: Literature review, manuscript writing and data interpretation
- Rehman A: Data collection and literature review
- Iqbal MM: Designed research methodology and literature review
- Naz T: Data analysis and literature review
- Asghar M: Data collection, analysis and interpretation
- Ehsan F: Literature review and manuscript writing
- Nasir M: Data collection, analysis and interpretation
- Hussain QM: Data collection, analysis and interpretation
- Afzal S: Literature review and manuscript writing