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NAPHTHALENE ACETIC ACID AND BENZYLAMINOPURINE ENHANCE GROWTH AND IMPROVE QUALITY OF ORGANIC SPINACH IN KITCHEN GARDENS

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ABSTRACT

The present study was conducted at the Kitchen Gardening Training Centre, Faisalabad, Pakistan to evaluate the effect of the plant growth regulators Naphthalene Acetic Acid (NAA) and Benzylaminopurine (BAP), on the growth and yield of organic spinach (*Spinacia oleracea* L.) in kitchen gardening. Different combinations and concentrations of NAA and BAP were tested to evaluate different vegetative parameters. The data were recorded at 40 and 60 days after sowing (DAS). Maximum plant height at 40 DAS was recorded for the combined effect of NAA and BAP at a concentration of 1000 µM (each), while BAP alone at 100 µM concentration showed maximum plant height at 60 DAS. Maximum number of leaves was shown by NAA (10 µM) both at 40 and 60 DAS. Increase in leaf length was observed for NAA (10 µM) and BAP (100 µM) both at 40 and 60 DAS. Significant increases in root length were recorded where maximum root length was in plots treated with BAP (1000 µM) applied 40 DAS while the mixture of BAP (10 µM) and NAA (10000 µM) induced significant increases in root length when applied 60 DAS. Maximum fresh weight of shoot was observed for NAA (1000 µM) and BAP (1000 µM) while maximum shoot dry weight was observed in plots treated with NAA and BAP at a concentration of (1000 µM) each. Similarly, a significant effect of plant growth regulators was observed on root dry weight where highest dry weight was noted in the plants treated with NAA at the rate of 1000 µM.

Keywords: Growth regulators, Organic farming, Kitchen gardening, NAA, BAP.

INTRODUCTION

Organic farming not only helps the grower to cut expenses compared to traditional farming where a lot of inputs i.e. fertilizers and pesticides are used, but also helps produce contaminant free products. Therefore, we may say that organic farming provides economic benefits and is a healthy way of producing fresh product for local consumption. Vegetables produced organically eliminate the chances of old-age diabetes, heart attacks and several such diseases due to its pure and chemical free composition (Willcox *et al.*, 2003). Rural communities in Pakistan are becoming well aware of the benefits of organic farming. Families have started their own kitchen gardens for daily vegetable procurements. These practices not only save them money by cutting down market purchases of vegetables, but also provide fresh and

healthy vegetables that could be helpful in recycling kitchen wastes.

Among several different vegetables, spinach (*Spinacia oleracea* L.) is one of the preferred leafy vegetables for kitchen gardening in Pakistan. It is an annual herb of the family Chenopodiaceae, native to West Asia, and at present, is widely cultivated in the world as a popular vegetable (Knoll *et al.,* 1997). Among fresh leafy greens, spinach is an important source of nutrients in the diet, ranking 2nd behind kale in total carotenoids and folate contents (*Holden et al.*, 1999, USDA, 2003). It is a rich source of Vitamin A, Vitamin C and several vital antioxidants. Spinach is high in folic acid (Cardwell, 2005). Recently, opioid peptides called "rubiscolins" stimulating memory function of the brain has also been reported in spinach (Hirata *et al.,* 2007).

The shelf life of spinach is less than 14 days after harvest (Kader, 2002). However, strategies to increase shelf life include reducing physical damage during processing and storing at lower temperatures in modified atmospheres (Price and Floros, 1993), which is difficult to manage in a developing country. Hence, growing spinach domestically in the backyard ensures supply of fresh and nutrient rich produce for domestic consumption. To enhance the yield of spinach, foliar application of nutrients could be a robust method. It is observed that foliar application increases crop yields by induced immunity against diseases and insect pests, improving drought tolerance and enhancing crop quality (Kothule *et al.,* 2003). Very dilute solutions of nutrient formulations (one cup to two quarts per acre of an active ingredient) are enough to produce such significant improvement in plants (Anonymous, 1985). At present, for example, foliar sprays of micronutrients are commonly recommended to correct zinc deficiencies in grapes (Williams and Williams, 1986), to control bitter pit and cork spot in apples (Greene *et al.,* 1995), and for general supplementary nutrition in strawberries (Deremiens, 1995). Similarly, the plant growth regulators may be used for stimulating growth in herbs (Salisbury and Ross, 1985).

In kitchen gardening, to cultivate vegetables organically for domestic consumption, use of a plant growth regulator is the best approach to improve the quality of the produce. The present study was carried out to evaluate the effect of Naphthalene Acetic Acid (NAA) and Bezylaminopurine (BAP) on the growth and yield of spinach.

MATERIAL AND METHODS

A series of experiments were designed and conducted at the Kitchen Gardening Training Centre, Faisalabad, Pakistan. The research work was carried out to study the effects of foliar application of NAA and BAP on the growth and yield of leaves, stem and roots in Spinach (*Spinacia oleracea* L.). Healthy seeds were selected for sowing after proper seed bed preparation. The seeds were sown in a randomized complete block design on 5th October 2014. All other standard cultural practices were carried out when and where needed.

The crop was sprayed with NAA and BAP at three times during growth i.e. 20, 40 and 60 days after sowing (DAS). The solutions of NAA and BAP of different concentrations i.e. 10 µM, 100 µM, and 1000 µM, and their combination mixtures were prepared in NaOH and were applied as foliar sprays.

The data were recorded one week after each application when plants were assessed for height, number of leaves per plant, leaf size and root length, and at the time of harvest fresh and dry weight of the crop was also recorded. The plants were harvested 85-90 days after sowing. The data were recorded and analyzed by applying Analysis of Variance (ANOVA) and the post *hoc* comparisons of means were conducted by the Least Significant Difference (LSD) Test (Steel and Torrie, 1984).

RESULTS

The results from the present study have demonstrated that growth and morphological components of spinach were significantly affected by different concentrations of growth regulators when applied 40 and 60 DAS. Treatments 20 DAS, however, had no significant effect (data not presented).

Plant height was significantly affected by the treatments both at 40 and 60 DAS. The maximum height of the plants (13.31 cm, 13.83 cm and 14.3 cm, respectively) 40 DAS was observed in plots treated with 1000 µM solution of NAA alone and as a mixture with 100 & 1000 µM solutions of BAP (Figure 1). Maximum plant height 60 DAS (33.40 cm) was recorded where 100 µM solution of BAP was applied while minimum plant height (28.66) was observed in the plot treated with 10 µM solution of NAA at 60 DAS (Figure 2). It is found that applying BAP alone to plants is very effective in enhancing plant height (Bhatt *et al.,* 1992; Sarwar and Skirvin, 1997).

No significant effect of any treatment was observed 40 DAS on the number of leaves per plant (Figure 1), however, 60 DAS it was significantly different to each other and the maximum number of leaves per plant were recorded in the plot treated with 10 - 1000 µM solution of NAA, which was significantly similar to other concentrations of the same growth regulator (Figure 2).

Mean values for shoot fresh weight indicated that the results were highly significant. Maximum shoot fresh weight (29.52 g) was observed with combination of NAA (1000 µM) and BAP (1000 µM) (Figure 3). Significant variation was also obtained in shoot dry weight. Maximum shoot dry weight (4.84 g) was observed for NAA and BAP at a concentration of 1000 µM each (Figure 3).

The results for root fresh weight were not significantly different from each other (Figure 3). In contrast, significant variations were found for root dry weights. Maximum root dry weight (0.62 g) was observed in plots treated with NAA (1000 µM) while the minimum weight (0.45 g) was recorded in control (Figure 3).

DISCUSSION

The treatments in which NAA was applied individually yielded better results. Similar observations were reported by Ulskov *et al.* (1992). Our results have indicated that NAA has a positive effect on vegetative growth of spinach plants when applied at the rate of 10 µM both alone and in combination with BAP (Figure 2). Literature reviewed has clearly mentioned that auxins increase the number and size of the leaves in different plants (Tuominen *et al.,* 1997, Awan *et al.,* 1999). Therefore, the positive effect of NAA, being a member of the auxin class of plant growth regulators, justified present results.

The present study showed that BAP alone or in combination with NAA is effective. This chemical belongs to the kinetin class of plant growth regulators and has been well known to enhance cell division in the presence of auxin (Cleland, 1996), and also promote bud and root formation, which is direct confirmation of our result. We have demonstrated that the cytokinin (BAP) has a major role in the

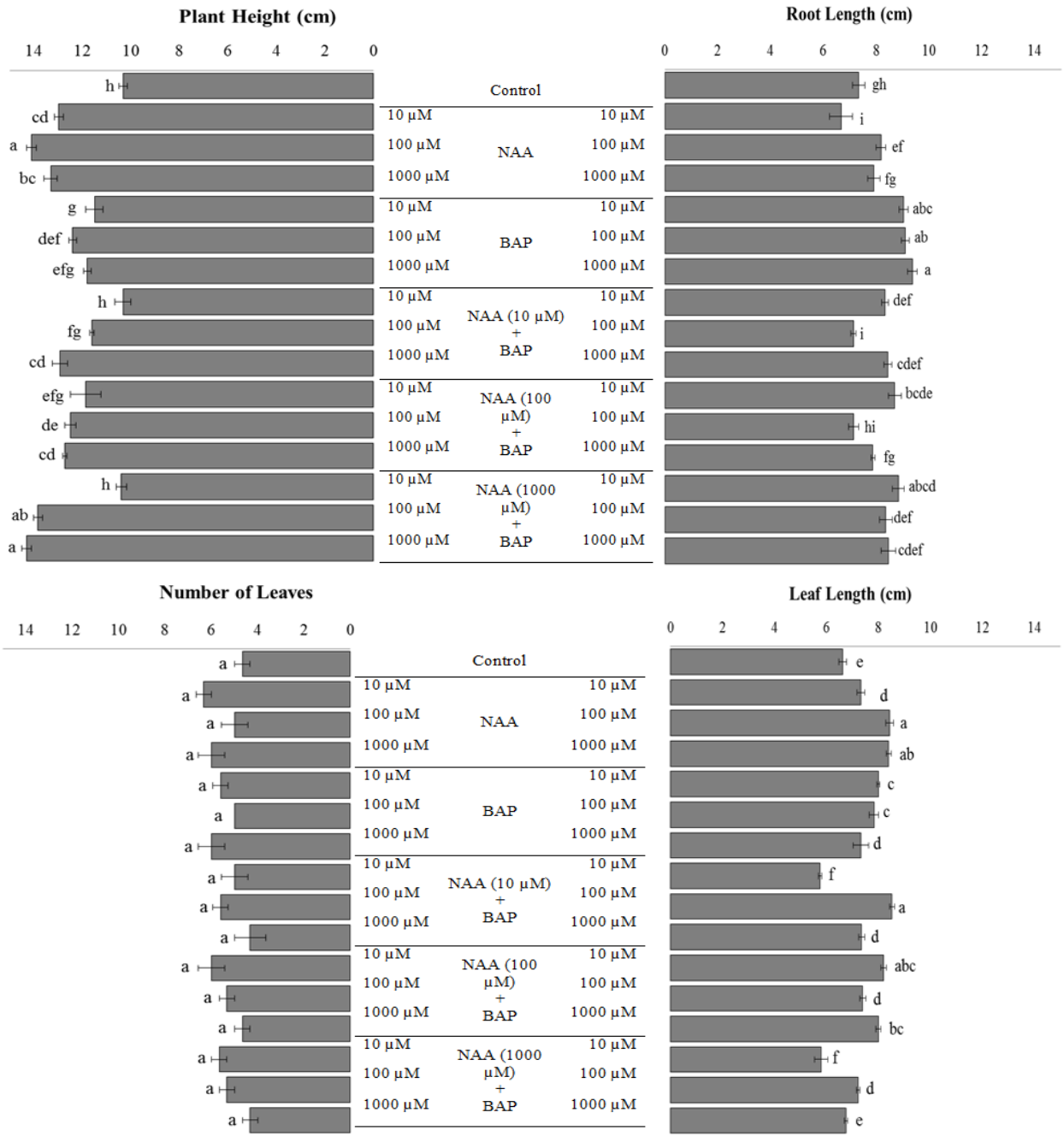

Figure 1: Effect of naphthalene acetic acid (NAA) and benzylaminopurine (BAP) growth regulators applied 40 days after sowing (DAS) on plant physical characteristics.

Bars represent means and the error bars are 95% CI. Bars sharing the same letters do not differ statistically from one another (P < 0.05; LSD test for multiple pairwise comparisons).

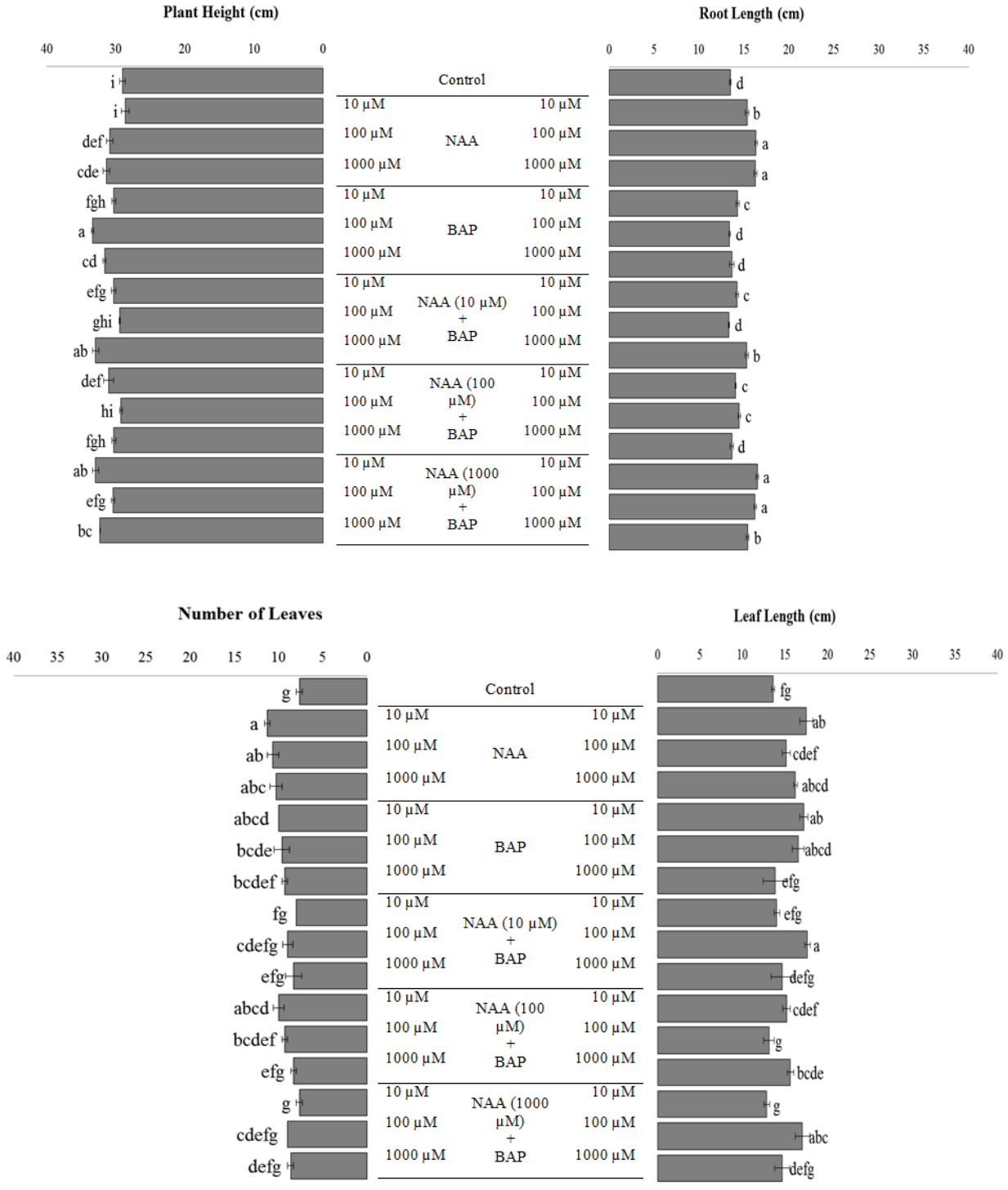

Figure 2: Effect of naphthalene acetic acid (NAA) and benzylaminopurine (BAP) growth regulators applied 60 days after sowing (DAS) on plant physical characteristics.

Bars represent means and the error bars are 95% CI. Bars sharing the same letters do not differ statistically from one another (P < 0.05; LSD test for multiple pairwise comparisons).

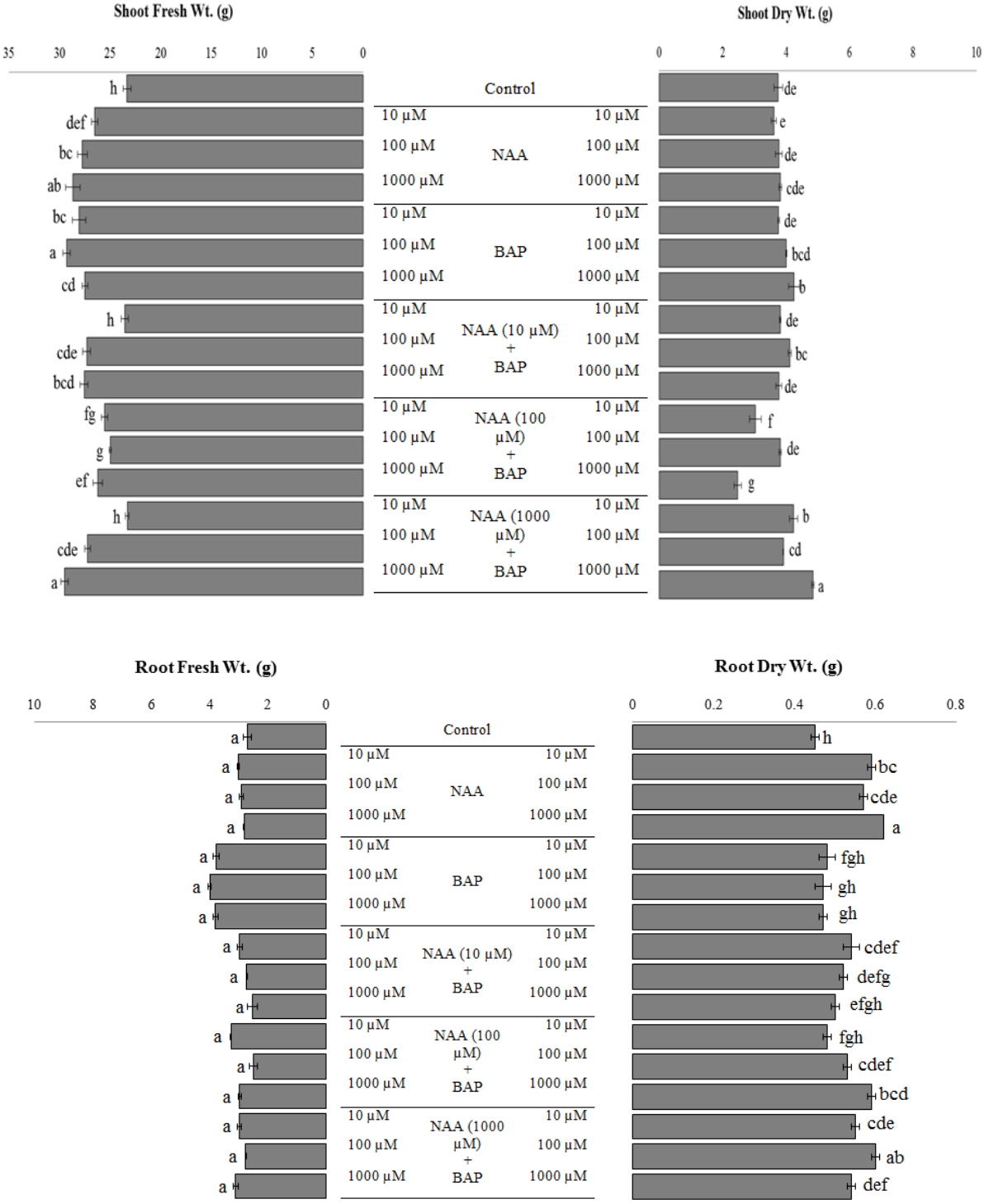

Figure 3: Effect of naphthalene acetic acid (NAA) and benzylaminopurine (BAP) growth regulators on plant yield at harvest. Bars represent means and the error bars are

95% CI. Bars sharing the same letters do not differ statistically from one another (P < 0.05; LSD test for multiple pairwise comparisons).

enhancement of biomass in the case of spinach. Similar studies conducted on garlic reporting elongation and increase in number of roots (Baren *et al.*, 1988) supports our results.

It was also noted that auxin and cytokinin (NAA and BAP) in any suitable concentrations resulted in maximum plant dry weight or biomass. Use of BAP was also found to increase yield in the *Brassica* crop and sugar beets (Yadav and Tikkoo, 2001). According to our findings, NAA and BAP in combination have a synergetic effect. Similar findings have been reported by Kalpana and Krishnarajan (2003) who had studied the effect of plant growth regulators on the soybean. A role, as enhancer of leaf size, was observed for NAA and BAP when applied in combination.

The results suggested that some of the growth parameters, such as leaf length, root length, shoot fresh and dry weight, were affected by the combined foliar application of growth regulators. Foliar application of BAP alone showed maximum plant height, while maximum number of leaves and increased root dry weight was observed by the application of NAA alone. In general, BAP (1000 µM) had overall best results on the growth and quality of spinach crop in kitchen gardens.

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