Spring-Seeded Winter Annual Rye as a Living Mulch in Dry Bean Production Systems.

Steven A. Wagstaff [1], Kurt D. Thelen [1], Nora M. Bello [2]

[1] Department of Crop and Soil Sciences, Michigan State University, East Lansing, MI 48823

[2] Statistical Consulting Center, College of Agriculture and Natural Resources, Michigan State University, East Lansing, MI 48823

Objectives

1. Evaluate the effect of rye mulch, herbicide regimes, and row spacing on weed suppression
2. Evaluate the effect of rye mulch, herbicide regimes, and row spacing on dry bean yield

Introduction

Michigan ranked 2nd in the nation last year for dry edible bean (*Phaseolus vulgaris* L.) production with 77,355 hectares under production in 2006, with an estimated wholesale value of $127,000,000. Michigan was also the number one U.S. producer of black beans in 2006, with 41% of Michigan's total dry bean acreage planted to black beans (USDA, 2006). One of the top challenges facing dry bean growers today is weed control. Spring planted cereal rye (*Secale cereale* L.) has shown potential for weed suppression in soybean cropping systems (Ateh and Doll, 1996, Thelen *et al.*, 2004) and could potentially be incorporated as a tool for integrated dry bean weed management. This study aims to evaluate the utility of spring planted cereal rye mulch for weed control in black bean cropping systems.

Materials and Methods

Field research was conducted at two locations: the Michigan State University (MSU) Research Farm in East Lansing and on a Gratiot County Michigan farm owned and operated by Mr. Jerry Grigar (GRI). The variety of black bean grown was Jaguar (Kelly *et al.,* 2001) and was planted at rates of 95 kg/ha for 19 cm spaced rows and 62 kg/ha for 76 cm spaced rows.

Both locations were arranged in a randomized complete block design with GRI in a split-plot design and MSU in a split-split-plot design. The main plots for GRI were rye planting times: (a) 1 week prior to dry bean planting (early or “e”), (b) same day as bean (simultaneous or “s”), and (c) no rye (none or “n”). The sub-plots were levels of herbicide application: (a) broad spectrum (bs), (b) broadleaf (bl) only, and (c) no herbicide (n). At the MSU location the main plots and sub-plots were identical to those at the GRI location. The sub-sub-plots were levels of row spacing with either 19 or 76 cm configurations.

Rye was planted in 19 cm rows one week prior to dry bean planting for early rye treatments. Rye was planted immediately prior to dry bean in simultaneous treatments. Herbicide treatments consisted of Basagran (bentazone @ 0.84 kg a.i./ha) and Reflex (fomesafen @ 0.28 kg a.i./ha) for the first broadleaf application and Basagran (bentazone @ 0.84 kg a.i./ha) and Raptor (imazamox @ 0.036 kg a.i./ha) for the second application. Broad-spectrum applications were identical to broadleaf applications except that Select (clethodim @ 0.036 kg a.i./a) was added for control of grasses. Plots were harvested via direct combine method, thus yields are presented as actual yields. Biomass measurements were taken at 93 days after planting (DAP) at the MSU site and 86 DAP at the GRI site.

Statistical analyses were performed using the MIXED procedure of the statistical software SAS (version 9.1, SAS Institute Inc., Cary, NC). Linear mixed models were used to fit the data, considering the experimental design for each site. Multiple comparisons between factor level combinations were performed using Bonferroni adjustments. Results are presented as estimated least squares means.

Results

Grain Yield: A significant interaction effect ($P = 0.0181$) was identified between rye cover and herbicide treatments regarding their mutual effect on grain yield at the Grigar site. Thus, results are presented for differences in yield between rye covers within types of herbicide (see Figure 1). A significant interaction effect ($P = 0.0017$) was identified between the rye cover, herbicide, and row space treatments regarding their mutual effect on grain yield at the MSU site. Thus, results are segregated by row spacing (19 cm and 76 cm) and presented for differences in yield between rye covers within types of herbicide (see figures 2 and 3).

Weed control: No significant interactions were observed for dry weed shoot biomass at the Grigar site for monocot or dicot weed species. Herbicide application had a significant effect at the Grigar site on weed shoot biomass for both monocot and dicot weed species ($P = 0.0002$ and 0.0154 respectively). Results are presented as differences in weed biomass between herbicide treatment within rye treatments to better show trends in the data for rye cover (see figures 4 and 5). No significant interactions were present at the MSU site for monocot weed biomass. The row space, herbicide, and rye factors were all significant ($P = 0.0006$, 0.0001, and 0.0001 respectively). Results are presented as effect of herbicide within rye cover on monocot weed biomass (see figure 6) to better show trends associated with rye treatments. A significant interaction ($P = 0.0069$) between rye and herbicide factors was present at the MSU site for dicot weed species biomass. Thus, results are presented as differences in dicot weed dry shoot biomass between rye cover and herbicide treatments (see figure 7).

2006 Grain Yield

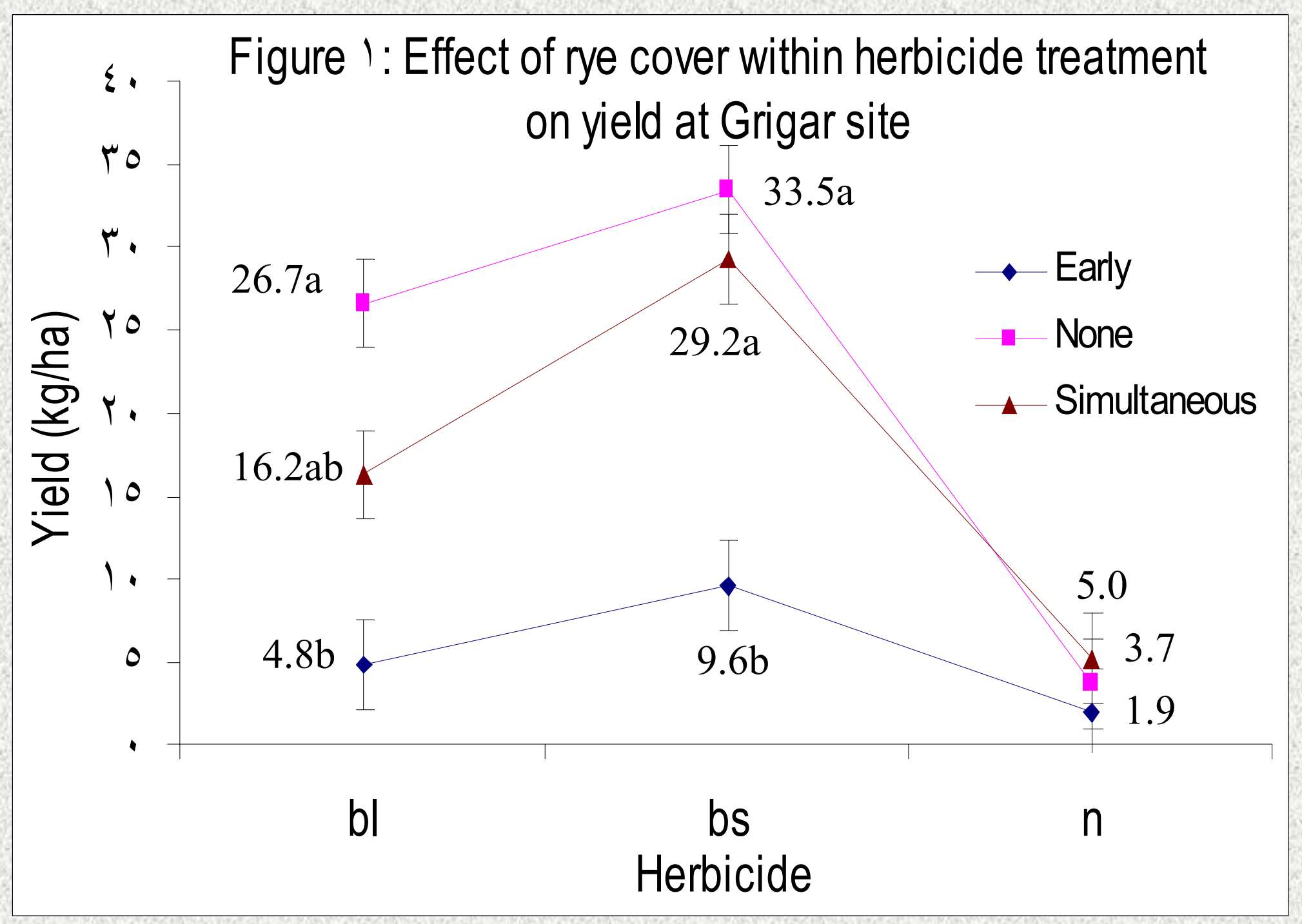
Figure ١: Effect of rye cover within herbicide treatment on yield at Grigar site

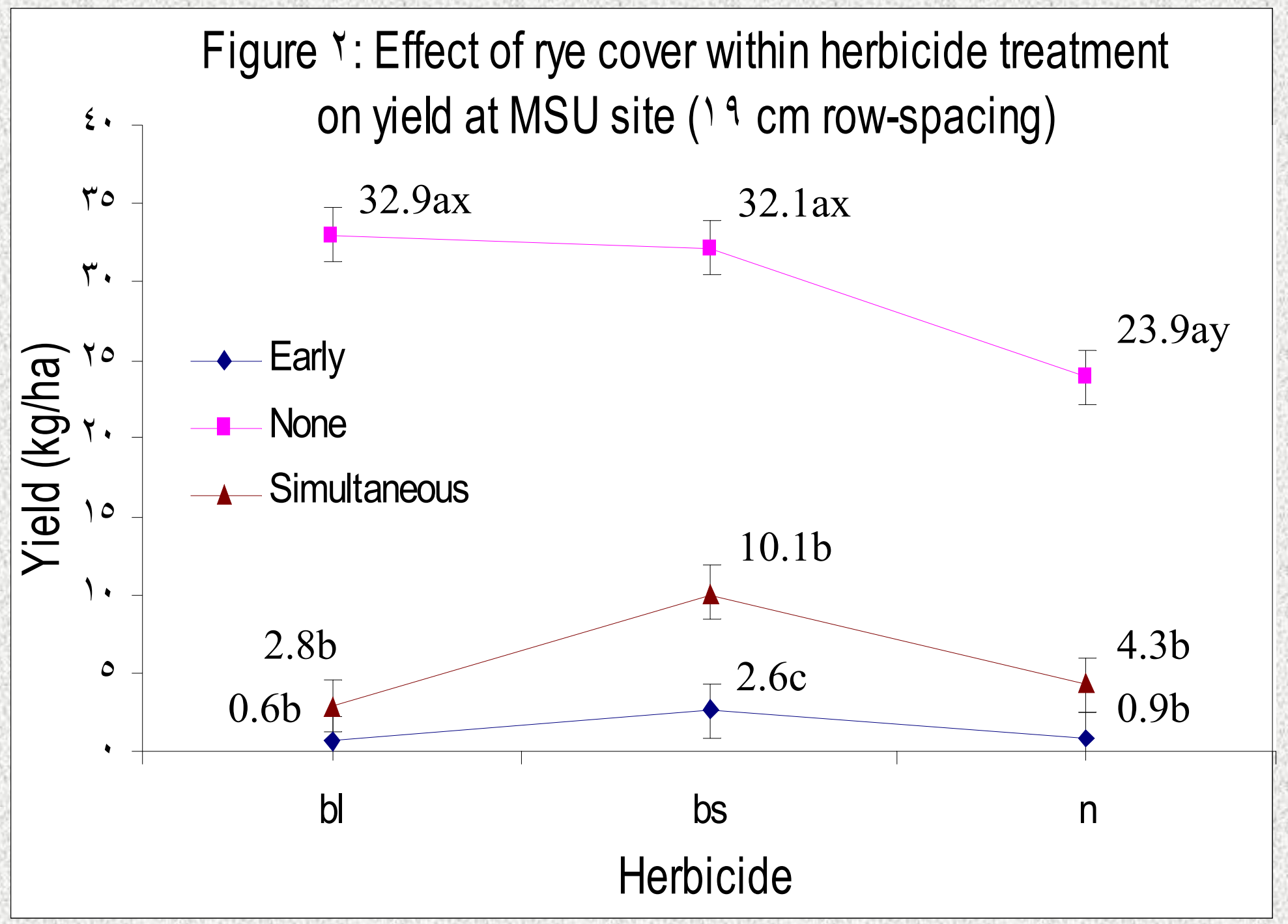
Figure ٢: Effect of rye cover within herbicide treatment on yield at MSU site (١٩ cm row-spacing)

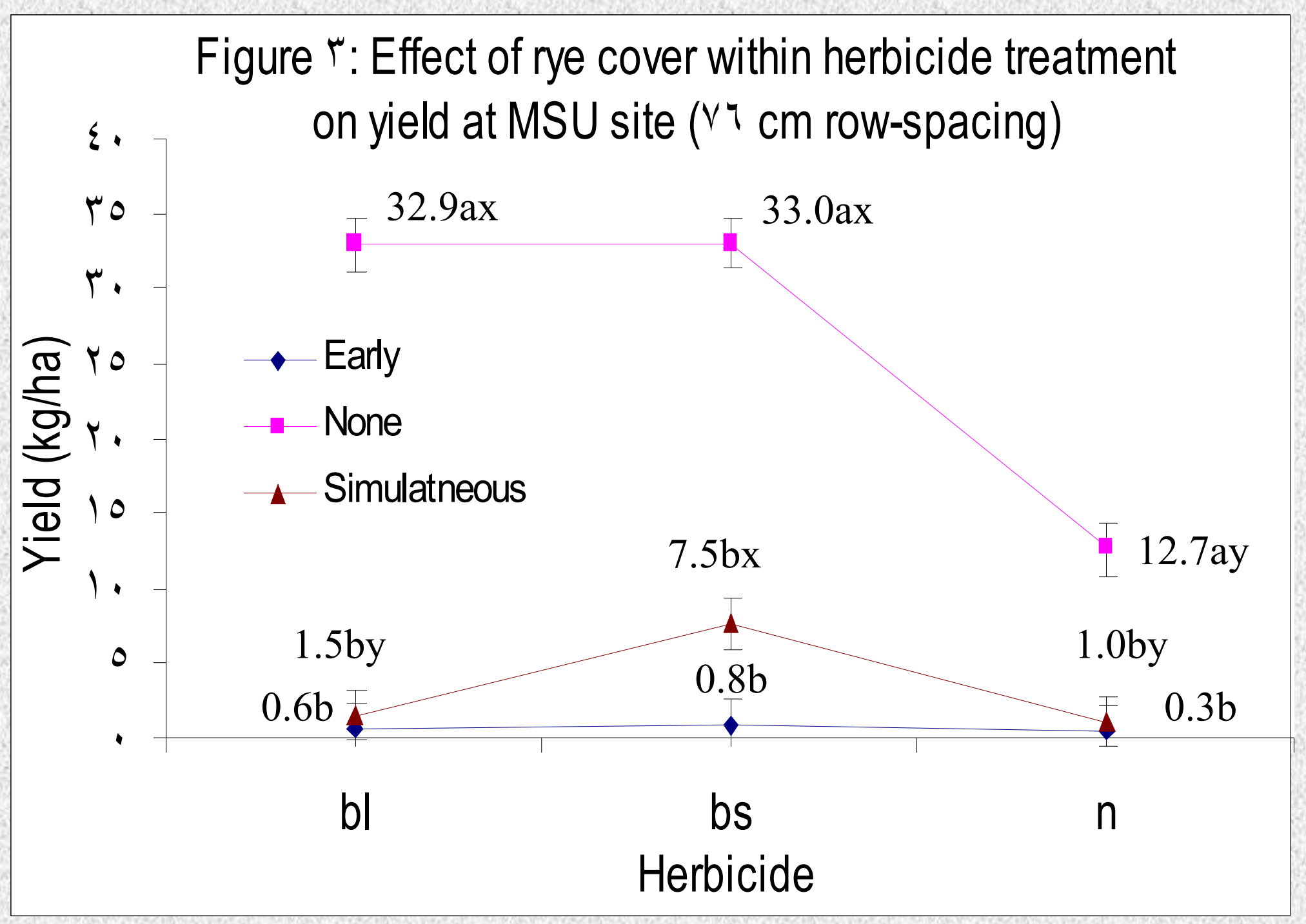
Figure ٣: Effect of rye cover within herbicide treatment on yield at MSU site (٧٦ cm row-spacing)

P < 0.05 Significant differences between means are designated with letters a,b, and c within classes of herbicide and with x, y, and z within classes of rye treatment. Means followed by the same letter are not significantly different.

Discussion

Rye cover reduced dry bean yields in all treatments at both locations, which may be attributable to competition for water and nutrients. Grain yields similar to no-rye treatments were present at the Grigar site within simultaneously planted rye treatments. However, this was not the case at the MSU site which may have been due to a larger nitrogen deficiency within rye treatments at that site compared to the Grigar site. Additionally, the Grigar site, being managed as a no-till system may have minimized water stress differences between rye and no-rye treatments. This indicates that a rye cover could be managed, in some circumstances, without a significant reduction in yield. Future research should focus on vigorous control of rye growth, perhaps planting rye earlier to establish biomass, and killing the rye upon prior to crop planting.

2006 Weed Biomass

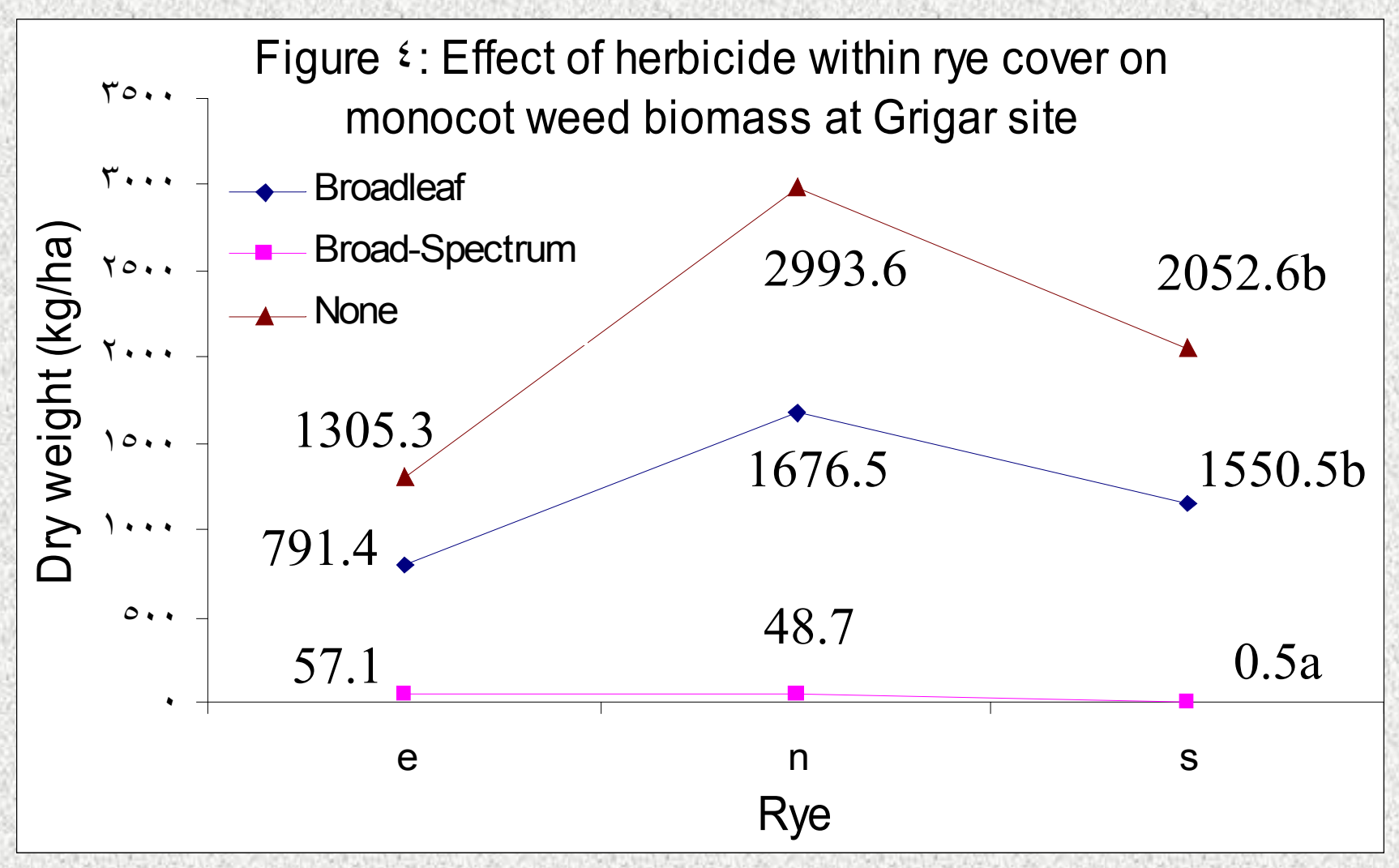
Figure ٤: Effect of herbicide within rye cover on monocot weed biomass at Grigar site

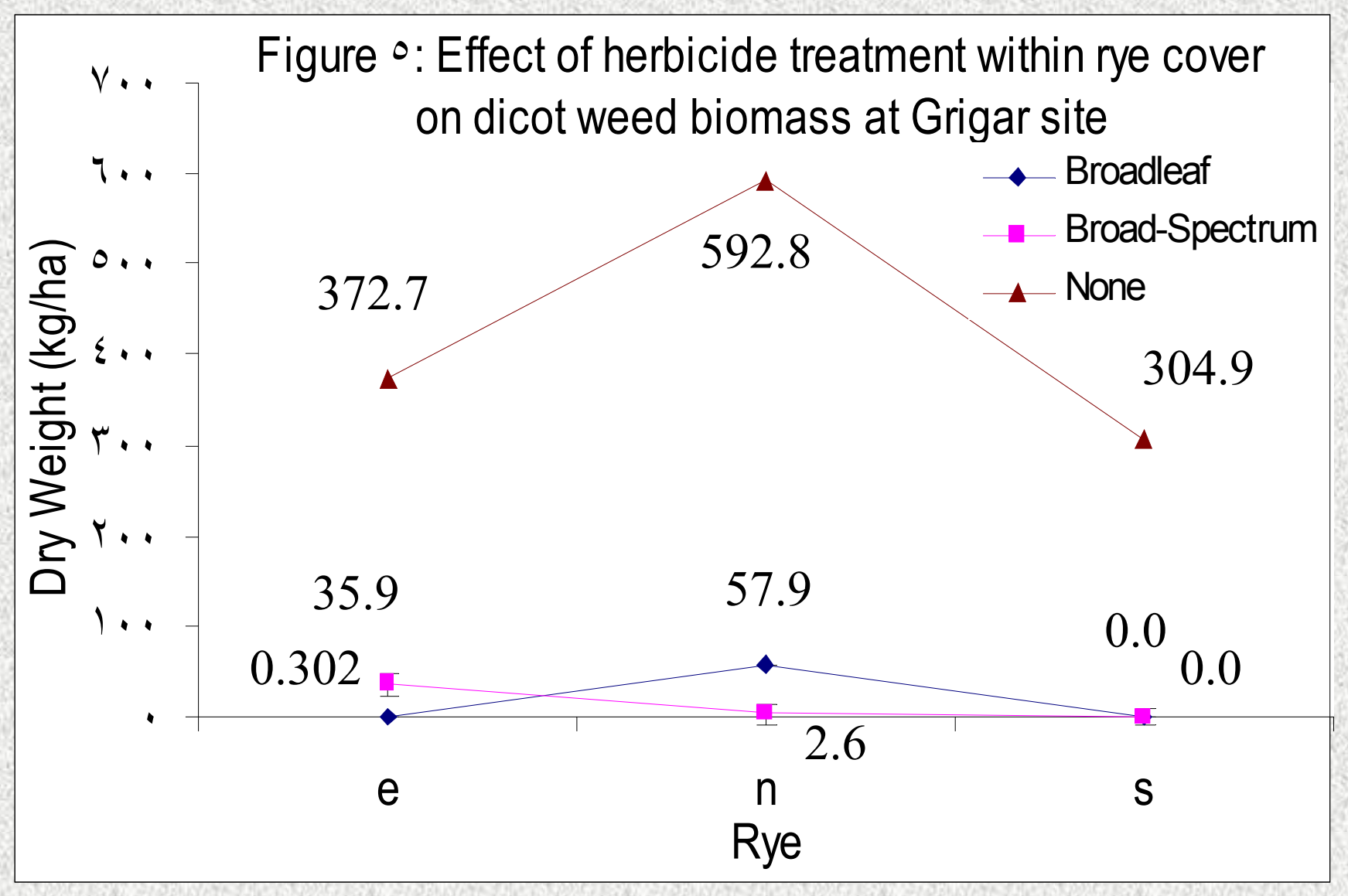
Figure ٥: Effect of herbicide treatment within rye cover on dicot weed biomass at Grigar site

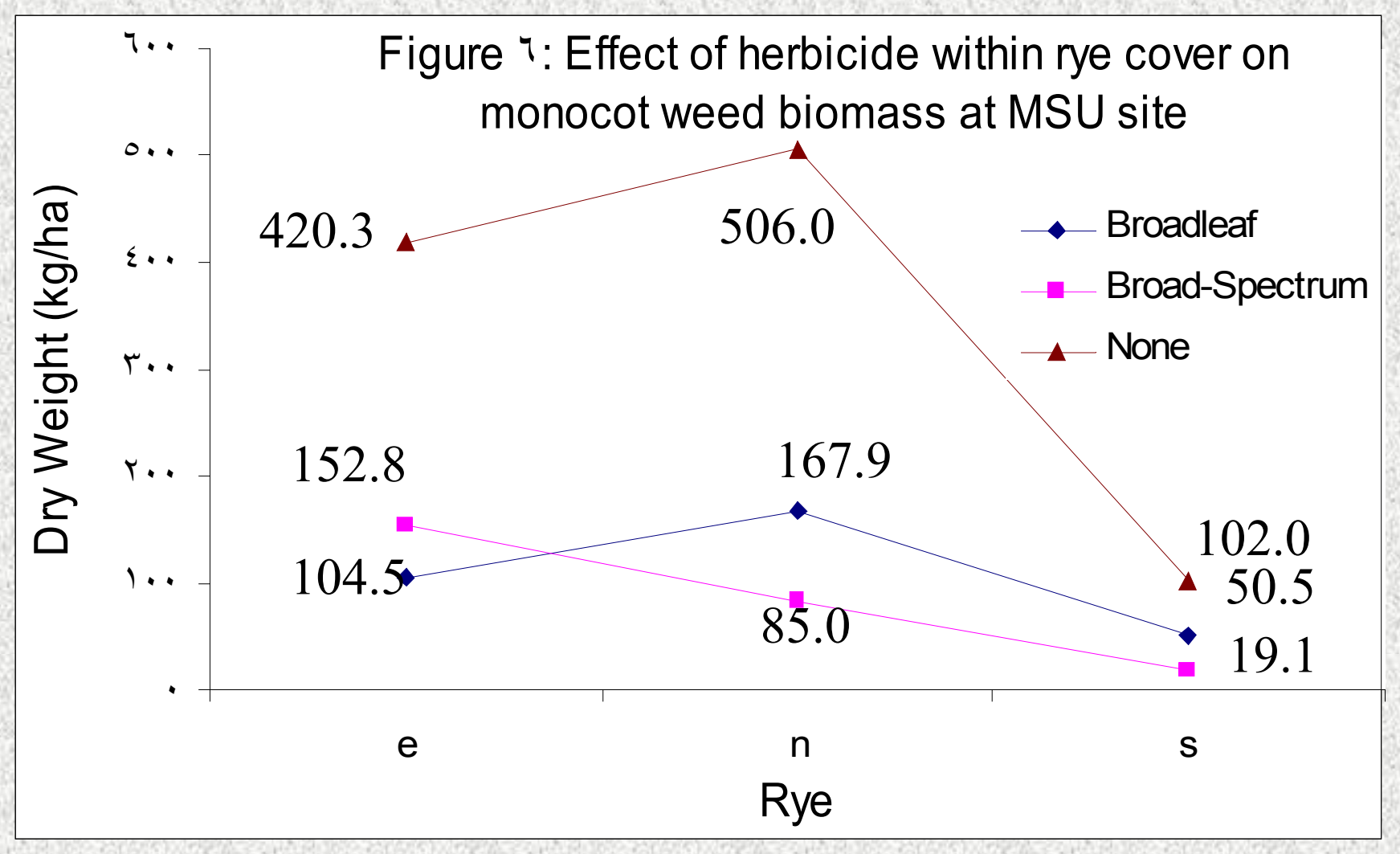
Figure ٦: Effect of herbicide within rye cover on monocot weed biomass at MSU site

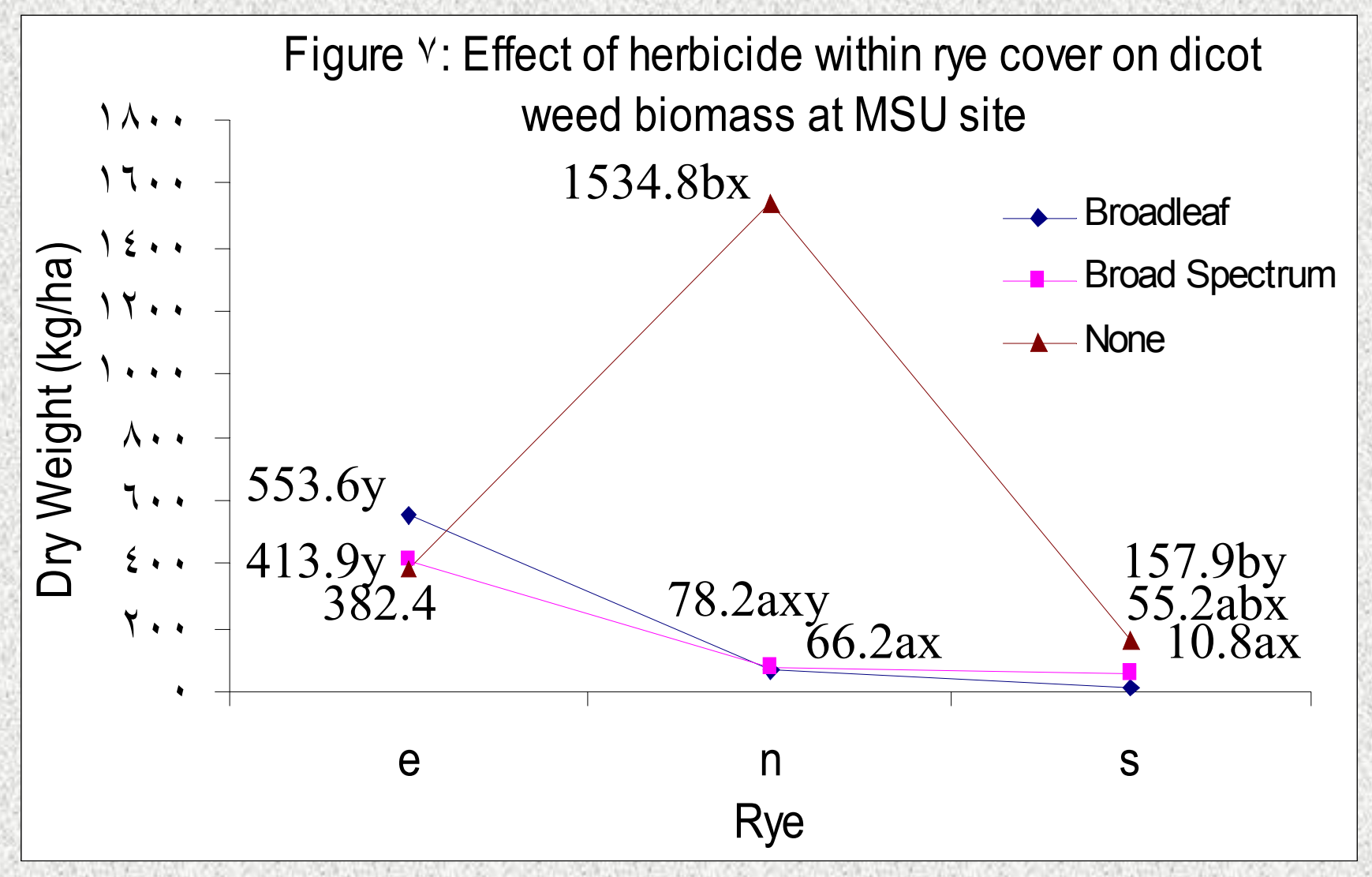
Figure ٧: Effect of herbicide within rye cover on dicot weed biomass at MSU site

P < 0.05 Significant differences between means are designated with letters a,b, and c within classes of rye and with x, y, and z within classes of herbicide treatment. Means followed by the same letter are not significantly different.


Above: Black bean with early rye in a 76 cm row configuration.


Above: Direct combine harvest of black bean.

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References

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