

A Quantitative Survey of Goldenrods and their Galls in Greencastle, Indiana.

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Introduction

- A gall is an abnormal growth of plant tissue in response to eggs laid by insects such as flies, moths, or midges. Our study focuses on three types of galls: ball, elongated, and rosette galls. Each gall is caused by insects of varying genera and species.
- This variation makes studying galls difficult especially when there is limited information available on the different kinds of insects present in an given area or what makes the galls from each insect unique. For this reason, we grouped the galls based on their morphological characteristics and not by the insects they may house.
- The gap in knowledge and existing literature on galls, with current literature favouring information on *E. Solidaginis* ball galls, also contributes to the difficulty to study galls.
- The females usually oviposit, in apical buds/ leaf buds, however, sometimes, eggs are laid on the body of the plant/around the plant and the young larvae migrate and bore holes into the stems of the plants.¹⁻³ The larvae use the galls as food and shelter, and then emerge from the galls as pupae.¹⁻³
- From previous literature, we know that different factors such as time of year, can also impact where the insects, such as *Asphondylia* species, lay their eggs and what kinds of galls are formed.³
- Our research was aimed at addressing two main questions. The first being the frequency distribution of the three galls across our three sites, while the second was the potential fitness cost of the galls on the goldenrods, specifically *Solidago altissima*.

Methods

- Three sites (Prindle, Campus Farm, and JD's field) with an abundance of goldenrod plants were selected.
- 75 plants were randomly selected and tagged per site

- Data collected:
 - Plant height
 - Oviposition scars
 - Gall present
 - Gall height
 - Gall diameter
 - Top necrosis/top lost
 - Nodding head
 - Percent surrounding vegetation (competition)



- A survey of about 3000 plants taken at each site

- Data collected:
 - Number of each gall type present
 - Number of plants with top necrosis/top lost



Campus Farm Prindle JD's Field

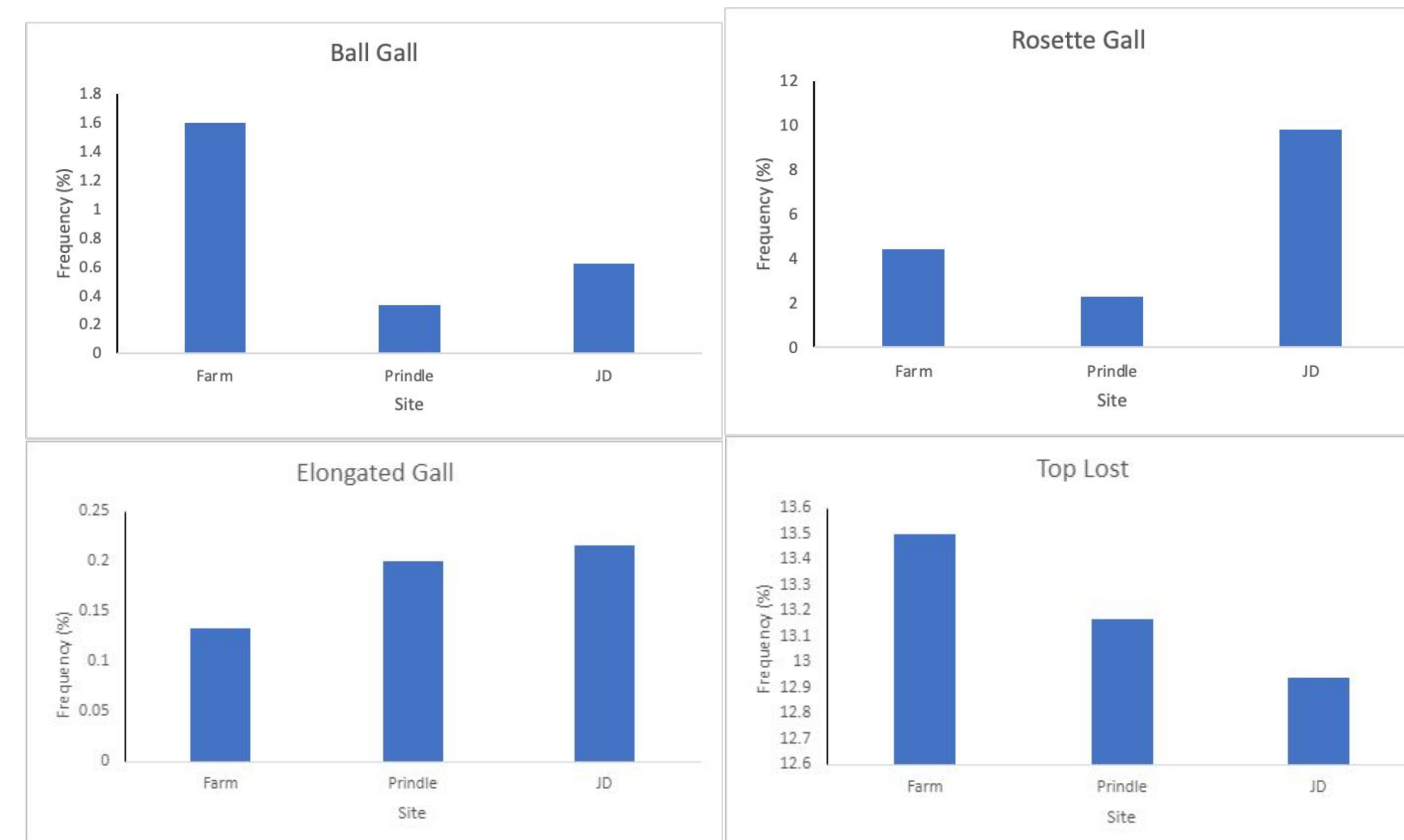


Fig 1. Survey data depicting the frequency (%) of galls and lost tops across all three sites.



Elongated gall⁴ Rosette gall Ball Gall Top Lost

Results and Discussion

- We found from our survey that the frequency of rosette and ball galls were significantly different across all three sites ($\chi^2 = 5.2075E-38$ and $\chi^2 = 1.58188E-07$ respectively). Elongated galls were the least abundant and hardest to qualify (as they can look like gall galls), and so it came as no surprise that the amount in each population was about the same. The rosette galls appeared to be the most abundant at each site, however, there is limited information available on them, making them harder to study compared to the ball galls.
- Some interesting future research could look into why variation exists among sites, especially since the sites appeared different from one another. JD's field was frequently grazed, the farm had more goldenrod along the paths, with denser areas further from the path while prindle had densely populated areas with variation in light accessibility.
- Another interesting research opportunity would be seeing if the pattern of rosette gall abundance is constant, or if the gall frequency and gall insect abundance fluctuate due to changes in environmental factors such as time of season, temperature, access to water, etc.

Future Work

- The second half of this project will be aimed at measuring the fitness cost of galls, especially for rosette galls that take over the goldenrod's main meristem. We intend to look at variables such as number of flowering heads, and seed output in conjunction with proxy variables such as height.
- Early attempts to test for a relationship between gall number, flowering stages and number of flowering heads were done with the prindle population, but there was no significant relationship between gall number and number of flowering heads nor flowering stage. However, there was a significant relationship between height and the number of flowering heads.

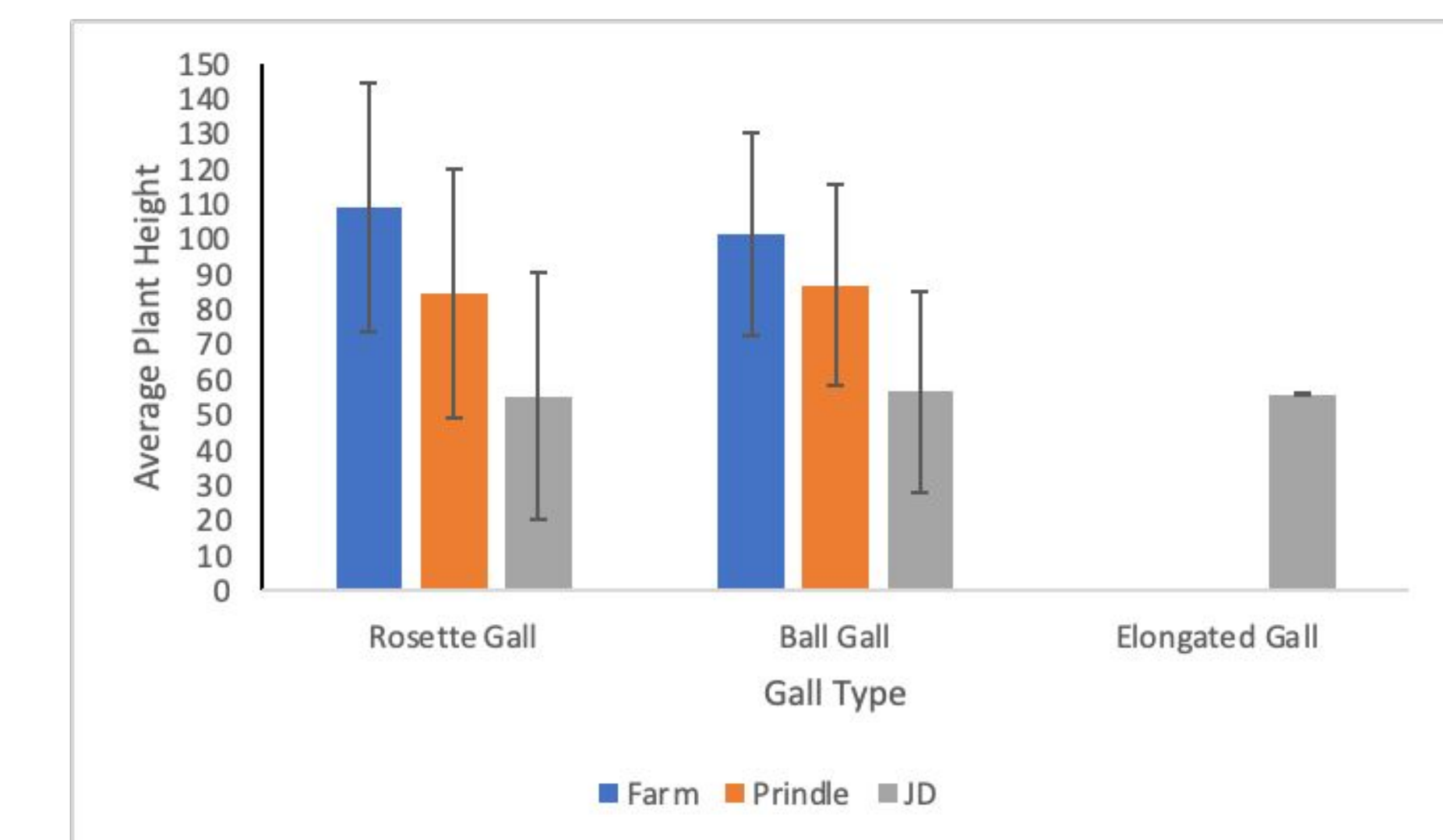


Fig 2. Graph depicting the average plant height by type of galls present.

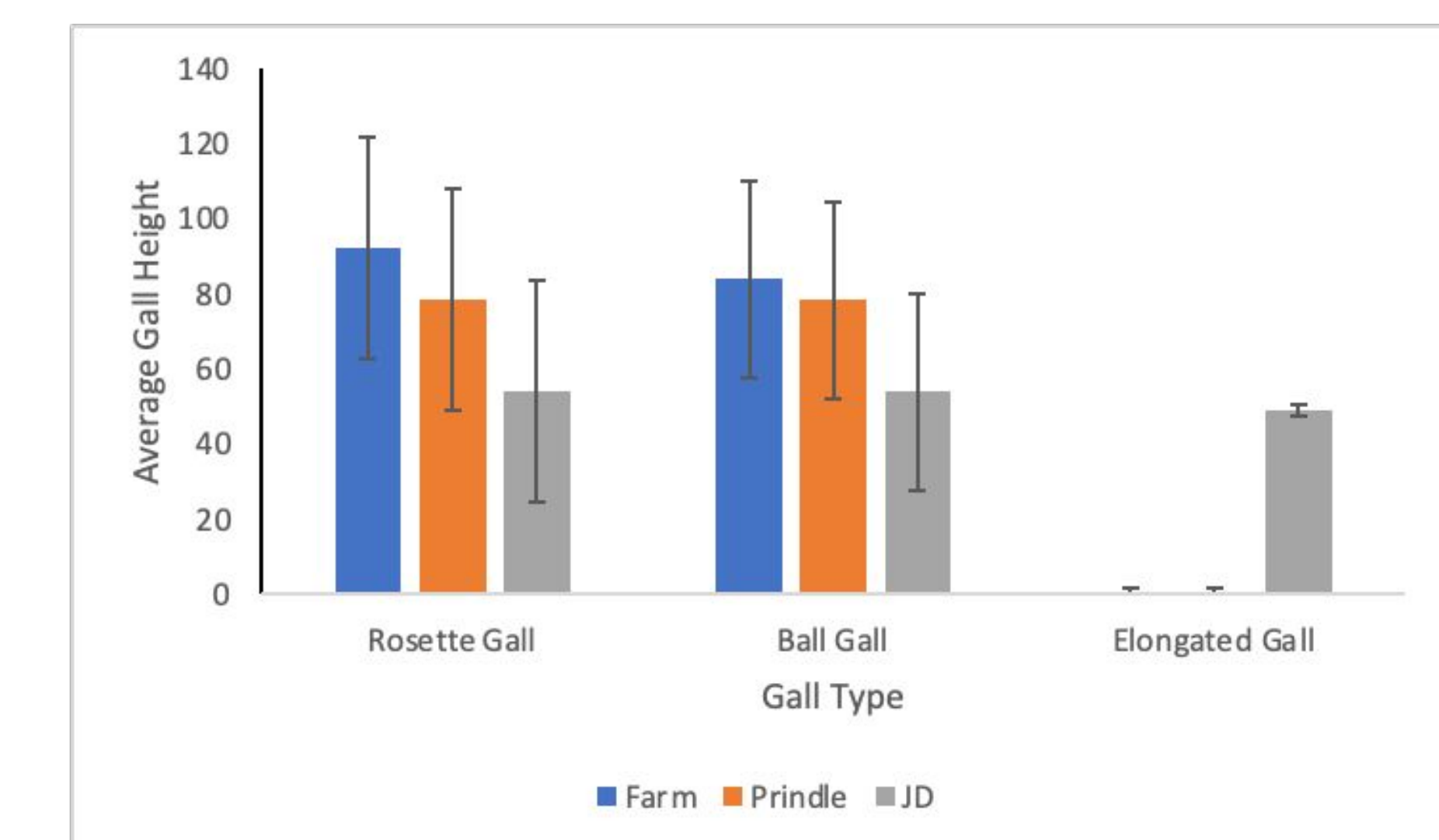


Fig 3. Graph depicting average gall height by type of galls present.

Acknowledgements

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